THE

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THE

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NOW IN PREPARATION.

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PROGRESS IN ELECTRICAL ENGINEERING.

THE presidential address with which Prof. Thompson opened the session of the Institution of Electrical Engineers, while not distinguished by any feature of striking novelty, had for keynote the word "Progress!" It must be admitted that no idea could be suggested that would be more appropriate to the conditions at this time prevailing in the electrical and allied industries than that of progress; the developments which we see taking place in every direction speak for themselves of the extraordinary rate at which electrical science is advancing, and of the prosperity of the industry.

The President's reference to telegraphy was confined to means of increasing the speed of transmission, with especial regard to submarine cable working. In this connection the Professor wonders why his suggestion, that inductive leaks of high resistance should be applied to the cable at intervals, has never been put into practice; as a matter of fact the experiment *has* been tried, not once but very many times, with innumerable combinations of inductive leaks, and the result in every case has been that either no advantage at all has been obtained, or else the working speed has been decreased. There are plenty of artificial cables on which the President could experiment if he were desirous of doing so.

Telephones are put in the corner in disgrace. Electrolytic lamps are touched on with a suggestion of "Why ever didn't we think of it before?"

The excessive cost of wiring buildings is considered to be, perhaps, the most serious obstacle to the spread of electric lighting, and the remedy is said to lie in the use of metallic conduits, and single instead of double insulation. We have heard this before, but are not yet convinced. While we accept steel conduits, or iron gas barrel, properly installed, as the best protection for the conductors, whether singly or doubly insulated, we cannot agree that this offers any prospect of combining cheapness with its other good qualities. The solution must be found, we believe, either in a concentric system, with earthed outer, or in a lead-covered twin-wire system, both of which are already in the field. We attach little importance to the fears so often expressed that such systems will suffer from mechanical damage, or to the craving evinced by some to pull the wires out of their ducts at unstated intervals; with the general adoption of higher voltages the drop of pressure in the wiring has been made of secondary consequence, the smallest size of wire to be used being determined more by mechanical than by electrical considerations, while the risk of fire due to mechanical injury to either of the types of wire referred to is absolutely trifling compared with the dangers of paraffin lamps and exposed gas burners.

The deep impression left by the Swiss re-union upon the President was plainly manifest in his treatment of the distribution of electricity from generating stations to con-

sumers. Holding before us the examples of the Kander Works and the lighting of Milan, the Professor pointed out the vast superiority of alternating currents, especially those of the three-phase variety, for transmission over great distances. We are persuaded that the one great fundamental reason for the use of high pressure alternating currents is the fact that alternators do not require commutators. "There's the rub!"—in more senses than one. It is an incontestable fact that, with equal maximum pressures, a given power can be transmitted by direct current with less copper than by any system of alternating currents that can be devised. Unfortunately, it is not practically possible—at present—to generate direct current at pressures above 4,000 or 5,000 volts; but who shall say what the future may bring forth?

As regards the use of three-phase currents for general supply at moderate pressures, we cannot follow the President. The statement that the direct current three-wire system merely substitutes three wires for four is most unfair, seeing that at the same time the sectional area of two of these is halved, and that of the third is usually reduced to one-fourth, other things being equal. In fact, instead of 16 : 12, the ratio in which the weight of copper is reduced is 16 : 5. To call the three-phase four-wire system the logical extension of Dr. Hopkinson's idea is also unjustifiable; more copper is required on this system than on the direct current three-wire system, *cæteris paribus*. It is noteworthy that wherever both power and light are to be supplied by the Swiss generating stations, they are as far as possible kept separate, and very often direct current is used for lighting, three-phase for power, in the same area. This is because of the effect of starting induction motors upon the power factor of the system, causing excessive variation of the voltage at the lamps if all are fed in common. In other cases, the lighting circuits are supplied by single-phase currents taken from *one* circuit only of the three-phase generators. It must be borne in mind, too, that on the Continent much greater variation in the lighting pressure is patiently endured by the consumers than an English *clientèle* would put up with.

The President, moreover, remarked that a direct current will not drive a motor. It is true that the current in any armature conductor alternates in direction; but it is continuous with regard to the adjacent pole piece. Supply the slip rings of a rotary converter with three-phase currents; it will not start if the pole pieces are laminated, but must be mechanically brought up to speed.

As for the fire risk, while it may be true that a grindstone is more dangerous than an induction motor, it is also true if for the induction motor we substitute a direct current motor of decent design. The fact that grindstones are not boxed in while motors are, is merely an illustration of the parable of the gnat and the camel, with application to the insurance companies.

The remarkable experiment described by Prof. Thompson on the parallel running of alternators may have a bearing on the practical working of generating machinery, but in what respect is not so clear as we could wish. Under the conditions described no light is thrown on the question whether, if the excited machine had been supplied with driving power, the other would have been damaged. As it was, the "unexcited" alternator was not only called upon to do the work of both, but, in addition, had to drive the idle machine. If both had originally been fully loaded, the former would have been overloaded by more than 100 per cent., with a consequent C^2R loss 300 per cent. greater than the normal—a condition under which it would soon come to grief, if the engine could drive it. We should be glad to know the effect of the *amortisseur* upon the characteristics of the alternator when running on an inductive load. We know that it would to some extent reduce the efficiency, but this drawback may, perhaps, be counterbalanced by greater gains in other respects.

Dealing with electric traction, Prof. Thompson naturally favoured surface contacts, and considered it an advantage that our cities are not disfigured by networks of overhead trolley lines. Apparently our large cities do not value this advantage, for Liverpool, Manchester and Glasgow are disfiguring themselves as quickly as they can get the materials to do it.

We really do not see the grave objections to the overhead trolley system, even in busy cities. *No* tramway, of whatever description, can be permitted in the busiest thoroughfares, such as the Strand or Cheapside; nor do we see that the overhead equipment interferes with traffic any more than the conduit or surface contacts. It is the *cars* that get in the way.

The President turns to Switzerland rather than to America for guidance as to the future development of electric railways. But why must we go abroad for guidance? Did not Great Britain lead the world in every department of our profession? and may she not do so still? Electric railways had their first beginning in this country, and were a practical success here before they had been even attempted elsewhere. It is unfair to draw a sharp contrast between the pioneer City and South London Railway and the brand new Burgdorf-Thun railway; but even if we compare these, we only find one radical difference—one is worked by direct current, the other on the three-phase system, and both are successful.

Let us be ready to adopt three-phase working if experience shows the need; but let us rely also on ourselves, without, however, rejecting experience gained abroad.

We cordially endorse Prof. Thompson's remark that unless the experiments now in progress at Earl's Court include a decisive comparison of the direct and alternating current systems, the expenditure is wasted; for of the practical ability of direct currents to work the traffic there is no room for question.

So many subjects were dealt with in the address that we must pass over many of them in silence. An interesting reference to the financial condition of the industry revealed the fact that no less a sum than £105,997,716 is invested in it at this time. The value of *Science Abstracts* as a means of disseminating knowledge among the members, and keeping them abreast of progress, was emphasised, and the address concluded with an appeal to the members, in support of a circular recently issued, to hasten forward the erection of a suitable and long-desired building for the housing of the Institution.

Physical Society Dinner.—A dinner given by the Physical Society was held one evening last week in the Victoria Hall of the Hotel Cecil. The president of the Society, Prof. O. J. Lodge, took the chair, and the guests included a large number of prominent members of contemporary scientific societies.

THE SUPPLY OF ELECTRIC ENERGY FOR TRACTION PURPOSES.

By PHILIP DAWSON.

The question of the best method of generating electrical energy for traction purposes is at present a most important one in Great Britain. There are probably few countries which present a larger field in this direction. Five years ago there were practically no electric roads of any very great importance. At the present moment we have some 400 miles of route on which some 2,000 electric tramway motor cars circulate. This, not including the cost of expropriation, Parliamentary, and other such charges, represents an actual capital expenditure of from £5,000,000 to £6,000,000 sterling.

Besides the lines mentioned, and which are already in operation, there are at least other 400 miles of route under construction, representing another five to six millions of money.

It is not probable or desirable that electric roads should be as recklessly built in the United Kingdom as has been the case in the United States. There, with some 60,000,000 of inhabitants, there exist, roughly, 30,000 miles of electric surface roads and 100,000 motor cars. Owing to our stringent laws and regulations, and to the solidity with which we always construct, roads in many cases would not pay in this country which would be very lucrative either in America or on the Continent.

It is not over-estimating to state that within the next five years we shall construct at least another 2,000 miles of electric tramways. This would only represent twice the mileage of tramways possessed by Greater New York, a city which is still inferior to Greater London in population and area. We can thus count on an additional expenditure of probably another £35,000,000 over and above the £10,000,000 or £12,000,000 already spent. The total expenditure within the next few years will probably therefore not be much under £50,000,000.

Leaving for a moment on one side the question of tramways, and looking at railways, there is, I believe, a future for the application of electric traction in this field as yet but little dreamed of and far surpassing the possibilities in any other country. The reasons for this are simple: we have large cities and we centralise the business. We have innumerable steam railways running into the hearts of our large industrial towns, bringing in millions of people daily. Land is very valuable and there are natural conditions which generally make it impossible for the railway companies to increase the number of their lines. Traffic is already so dense, that in most cases the railway companies are running as many trains on their city and suburban lines, as they safely can by steam. The use of electric traction would, owing to the rapid acceleration obtainable with electric motors, enable the railways to greatly increase the average speed of their trains, and therefore to augment the number of trains by 50 per cent., if not to double it.

In London alone we have, counting all the railways including the Metropolitan and District, probably at least 1,000 miles of track which might advantageously be equipped electrically. The same, although not on such a large scale, holds good of our other large commercial centres such as Liverpool, Manchester, Birmingham, Sheffield, Glasgow, &c. In these towns there would altogether probably be at least another 1,000 miles to be equipped. It is probable that the railway companies will soon realise the necessity of introducing electric traction, and, indeed, several of our large railway companies are already studying the subject. The introduction of electric traction on railways, owing to the greater speed and hence greater power required and more intense service, will probably not cost much under £10,000 a mile. We may probably, therefore, look forward within the next few years to an expenditure by our railway companies of not far short of £30,000,000; this, added to the £50,000,000 which by that time will have been expended in electric tramways and light railways means a total expenditure, in the next few years, for electric traction alone, of about £80,000,000.

The annual average number of car miles run per mile of route is probably not much under 150,000 and may, in many cases, reach 200,000. Including the railways which will be equipped, it is probably safe to estimate on the latter figure.

Supposing, therefore, that tramways, light railways, and railways included, we shall, in the next few years, have some *5,000 miles* of line, we get an average total annual car mileage of over *1,000,000,000 car miles run per annum*. Taking the total working expenses at, say, *fourpence-halfpenny per car mile*, we get a total annual expenditure of, roughly, *£20,000,000*. The cost of power varies approximately between 10 and 40 per cent. of the total working expenses as set forth above. The total annual expenses for the "Supply of Electric Energy for Traction Purposes" may therefore be expected to reach within the next few years from *£2,000,000* to *£8,000,000*.

This preamble will serve to show what an important question it is not only to get an absolutely certain and continuous supply of energy, but also to attempt in every possible way to reduce the cost of supplying the same.

It is evident that different cases will require different treatment. We will, therefore, briefly consider the cases which will generally present themselves, and then attempt to indicate the line of thought which might be pursued in solving the problem of cheap and certain supply.

We may practically divide the systems to be supplied as follows:—

Tramways.	Tramways in densely populated cities.
	Tramways in smaller towns.
	Light railways connecting populous industrial centres.
	Light railways connecting country towns and pleasure resorts.
Railways.	Metropolitan and suburban railways.
	Link between centre of city and railway terminus.
	Long distance railways.
	Light railways connecting rural districts to main line.

The system to be supplied, however, does not dictate the design of the generating station and supply system. The conditions which govern this may practically be summarised as follows:—

Big town, large population and heavy traffic lines.	End of longest line not more than four miles from supply station.
	Impossible to locate economically station near centre of system.
	Station centrally located with exception of one or two long outlying districts.
Small town, lighter traffic.	Station in centre of lines, no very long line.
	Station in centre of lines with one or two longer branches.

In the above sub-division it has been supposed that a given location of power house is not imposed.

Before proceeding any further it may be well to point out some of the radical differences between lighting and traction. A traction station as a rule runs at least 22 out of the 24 hours, the load factor is therefore much greater than in a lighting station. The average output is, as a rule, also much larger. For example, where are there lighting stations to be found which can be compared to the 96th Street power house of the Metropolitan Street Railway, of New York, which contains *eleven* 3,500-KW. direct connected generators? Or to the New Manhattan New York Elevated Railway power house, now under construction, which will contain ten 6,000-KW direct connected generators, or the New York Third Avenue line now under construction, in which there will be 10 direct connected 3,000 KW. units?

In traction work owing to holidays and special circumstances, such as races or games, unexpected overloads are always possible and must be coped with. The load must necessarily be a very fluctuating one, the average being probably in large stations about 75 per cent. of the maximum ordinary load.

Where continuous current machines are used the voltage must be fairly constant, and the maximum variation of speed of the engine must be small so as to allow compound wound dynamos to run economically and satisfactorily in parallel.

Where three-phase generators are used the variation of angular velocity must be very small, a maximum variation of about $\frac{1}{4}$th per cent. of angular velocity during one revolution being all that is permissible.

The special conditions which maintain are therefore, amongst others, practically continuous running, and probable and possible very heavy and unforeseen overloads. A far shorter time is available for overhauling the machinery, and as it is not economical to have very much spare power the

machinery should be of such type as to run with very little care, supervision or chance of accident. In a traction station the efficiency of the generating plant is a far greater factor than in lighting, owing to the practically continuous load. Time and labour-saving apparatus find therefore a far better application than would otherwise be the case, and larger capital expenditure is justified. Furthermore, economical engines both as regards steam consumption, repairs, maintenance, and depreciation, become necessary.

Plants originally designed and well adapted for lighting are more than useless, and the combination of a traction station with such is fatal. On the other hand, combining lighting with a traction station may, in many instances, prove exceedingly successful.

Considering the sub-division of possible plants which has been made, the following systems may, in each case, be considered :—There can be no iron bound rules, and in each particular instance the relation of power producing expenses, total working expenses, capital expenditure, interest and sinking fund on same must always be most carefully considered before deciding on the system to be adopted.

In choosing the location of a power station, it should be, of course, as nearly situated to the centre of distribution of the whole system as economically possible. The ground on which it is located should be easily accessible by rail and water, so as to get fuel easily and cheaply. Good feed and condensing water should be obtainable, and the ground should be such as not to cause very heavy expense in sinking the foundations of the various buildings.

Where the station is fairly central and the lines do not go much beyond three or four miles from the power house, continuous current generators, with possibly boosters to supply the distant and hard worked lines, may advantageously be used. Even where the station is centrally located, when the traffic is very dense and the total power required exceeds from 4,000 to 5,000 KW, three-phase generators with sub-stations and rotary converters may become advisable. Where three-phase plant is used, with few exceptions, no continuous current generators should be used, but all continuous current should be supplied by rotary converters even in the station itself, as the reaction of continuous current generators through the line on to the rotary converters makes governing difficult.

Where the station is centrally situated, but with one or two lines going out a long way, continuous current generators may be used, one or more polyphase generators, preferably driven by continuous current motors in the main station, sending high tension current to rotary converters in sub-stations near the extremities of the outlying lines.

In a small system when the station is centrally located, gas engines driven by water-gas made on the premises, and in parallel with accumulators, may, in many instances, prove most effective, especially where coal is expensive. It is the cost of the coal which will indicate whether in such a case gas or steam engines are the most advantageous. A gas plant will probably cost about 25 per cent. more than a steam plant, but the coal consumption and labour required with gas are less than with steam, and it will be the entire producing expenses required by steam as compared to the sinking fund and interest on the greater capital expenditure required by a gas plant, which will guide in coming to a decision.

Where a small plant cannot be located centrally, a subsidiary battery of accumulators and a booster located in the battery sub-station may prove of the greatest value.

In choosing the number of units for a traction plant, they should be as small as possible in regard to economical working. Thus, for example, in a station requiring a maximum power of 200 I.H.P., we might have two units of 200 I.H.P. each, whereas in a station requiring a maximum I.H.P. of 90,000, we would have 10 units of 10,000 I H.P. each. Thus in the first instance a reserve of 100 per cent. would be necessary, whilst about 10 per cent. would be sufficient in the last case.

Continental and American experience of traction work has led to the nearly universal adoption of large slow speed engines. In England it seems as if this lead were now being followed, although with us owing to the special conditions that obtain in marine work, such excellent high speed engines have been devised that in many instances similar engines have been successfully used for traction purposes. At the same time marine conditions where the space is limited, and where it is advantageous to have the smallest and lightest and yet powerful engine, are totally different to those which maintain in traction work. In that case space and weight do not matter, the chief point is to have a simple, economical, and abnormally vigorous engine; refinements which are, therefore, most important in marine practice are entirely out of place in a traction plant.

There are, of course, cases such as the City & Waterloo, where space is limited, and in such cases marine experience is naturally of the greatest utility.

There is a great difference between over 8 lbs. of coal burned per Board of Trade unit generated at the switchboard and 3 lbs. of coal practically of the same calorific value. This difference in coal consumption alone, assuming the mileage referred to previously, would amount to about 3,000,000 tons of coal per annum, an amount which would correspond to approximately one-and-a-half millions of our money. The above corresponds to the difference between some high-speed marine and Corliss type engines.

In passing, the difference between European and American practice may briefly be noted. In the former it is nearly always usual to use three or more bearings, whereas in America two bearings are nearly universally used, the armature and shaft being either pressed on, one beside the other, or forming one, a bearing being located at either end of the shaft.

Attention may be called to the fact that this was the alternative offered to the Glasgow Corporation by the American engine builders who tendered.

It is hoped that the above few remarks may be of value to those interested in traction work. It is certainly desirable that our engineers should carefully digest what has been done elsewhere, and not under-estimate their competitors. This once done let us go ahead on our own lines and we are sure to be right. Lines built as carefully and solidly as those in the United Kingdom are not to be found the world over.

SOME NOTES ON ROTARY CONVERTERS, WITH SPECIAL REFERENCE TO THE EXTENSION PLANT OF THE CHICAGO EDISON COMPANY.

By A. C. EBORALL.

Assuming it to be advisable to distribute and use continuous current for all such purposes as power, traction, and lighting, —an idea which appears to have taken strong hold in this country amongst the majority of those responsible for laying out large schemes and plants—and as, on the score of economy, it is necessary for all large or extended areas to be fed with high tension polyphase current, means have had to be found whereby this polyphase current can be converted (in suitable sub-stations) into direct current for feeding the networks. There are two ways of doing this, one of which has been very extensively used. The first is by means of motor-generators, the second, by means of rotary converters.

Although it is certainly true that the latter type of machine forms, in many cases, the best connecting link between the polyphase and direct current circuits, yet it certainly appears to the writer that the claims of the motor-generator in this connection have been hitherto somewhat overlooked, and that there is an undesirable tendency in this country to copy rather too closely the American importation and practice, and to lay down rotary converter plants for every case arising. A brief consideration of this matter may perhaps prove of interest here, and possibly lead to a profitable discussion in future columns of the Electrical Review.

A.—*Motor Generators.*—In this case, the conversion of the high pressure polyphase current into low pressure direct current is made directly, there being no intermediate apparatus. Each set will consist of an asynchronous polyphase motor direct-coupled with an ordinary direct current generator, the two machines being preferably upon the same bedplate. The two or three-phase motor, as the case may be, runs practically synchronously at no load, the speed falling not more than 3 per cent. at full load, and 5

per cent. at 50 per cent. overload. The set can be economically started from either side, with the greatest celerity and ease, even by a quite unskilled attendant. If it is required to start up from the polyphase side, which would invariably be the case, all that has to be done is to throw over the high-tension switches, and gradually move the handle of the rotor resistance round until the latter is short-circuited. The current taken at starting would never exceed 50 per cent. of the full load current, as the combined sets would naturally start up without load. On the other hand, should it be desirable to start up from the direct current side—a case that could only occur should the rotor resistance of the asynchronous motor break down,* all that has to be done is to run up the set from the generator end, using the latter as a direct current motor, and to switch the polyphase motor in as soon as approximately normal speed is attained. Synchronising is, of course, quite unnecessary, and the polyphase motor can be switched in without affecting the network, and, indeed, without taking appreciable current, even if the speed is 10 per cent. above or below the normal.

As the motors are asynchronous, any number of sets, of any size, can be run in parallel without the slightest interchange of current, and without hunting. There is no excitation to be adjusted, apart from that of the direct current generators (not even here if the generators are compounded), and the running of the sets is absolutely independent of the quality of the engines. Once the motors have been switched in, they can be left to themselves, as no adjustments are necessary with varying load.

The switchboard necessary for controlling motor-generator sets is a very simple affair. For each set there are only required high-tension switches and fuses, low tension switches and fuses, one alternating current amperemeter, one direct current amperemeter, one direct current voltmeter, one starting resistance, and one field regulator and switch. Of course, there would be an alternating current voltmeter on one pair of the polyphase bus bars, and wattmeters or watt-hour meters can be added at discretion. The advantages of simplicity of switchboard and gear cannot be over-estimated for sub-station work.

With regard to the important points of efficiency and power factor, with motor-generator sets above 100 KW. output (which alone the writer has in his mind), the efficiency would not be less than 90 per cent. above three-quarter load, and the efficiency curve is quite flat between this and a 25 per cent. overload. Again, the power factor would not be less than 90 per cent. at three-quarter load, increasing to 92 per cent. with greater loads. It should always be borne in mind, that the design of motor-generators is much more flexible than is the design of rotary converters, this being a point that will be again referred to later on. A suitable speed for the sets being settled upon, this fixes the number of motor field poles, but the number of these poles does not materially affect the quality of the design of large induction motors. On the other hand, the direct current machine is designed absolutely independently of the motor, and will have the number of poles giving the best result from the commutation point of view. Also the line pressure is quite independent of the direct current pressure, and does not form a fixed proportion of it. The latter can be varied in the simplest possible manner, either by a compound winding, or by means of a regulator in the shunt circuit of the generator. Again, any of the direct current machines forming the generator parts can be connected together for feeding three-wire networks, for instance, without influencing the motor parts in any way.

The overload capacity of a motor-generator set is determined by the sparking limit of the direct current generator, that is to say, the set would have an overload capacity of not less than 25 per cent. The output of the motor depends practically upon the heating limit, which would be very high on account of the nearly fireproof construction, and, as a matter of fact, all well designed polyphase motors will carry a 75 per cent. overload for say, one hour, without damaging themselves. On the other hand, the heating limit of the generator will occur at a greater load than its sparking limit, on account of the low full load temperature rises invariably specified in England. An important point in connection with motor-generators, and due to the nature of the motors, is that a momentary short-circuit will not cause the motors to pull up, as is frequently the case with synchronous machinery; and moreover, should the motor tend to pull up from any cause, it will do so unwillingly, and should the cause be removed before the speed has dropped below about half synchronism, it will "pick up" and run up to normal speed again. Again, should one phase of the transmission line to the sub-station breakdown, or one phase of the generators in the power house, the motor-generators will in all cases continue running as single-phasers, and will develop, when running under these conditions, about two-thirds of their normal output as polyphase sets. This is also true of synchronous machinery, but not to such a great extent.

On account of the simpler character of the machinery, the much smaller amount of auxiliary apparatus, and the greater familiarity of the machinery and its adjustments to the attendant in the sub-station, the risk of breakdown is less with motor-generators than with rotaries, and moreover, in the former case, should such a thing occur, the fault is more easily found and put right, and the attendant is more likely to know what to do.

Finally, with regard to the cost of the sub-station plant, and the cost of maintenance and attendance; almost invariably, the cost of the motor-generator and switch gear will be approximately equal to the cost of rotary converters, switch gear, and the necessary step-down transformers, and in some cases it will be found to work out a trifle less. The cost of maintenance will be about the same in each case, but the attendance required by the machinery is in general less with motor-generators, and also a highly trained and experienced attendant is unnecessary. So that, bearing the first two considerations in mind, motor-generators come out better than rotary converters on the following points:—

Summary I.

1. There is no intermediate apparatus between the motor and the line, as the former is connected directly to the line conductors.
2. The sets can be started equally well from either end with the greatest ease, by unskilled labour if necessary, by means of the simplest possible arrangements, the starting current being inconsiderable in either case.
3. Perfect parallel running without synchronising. Moreover, it is independent of the suitability of the generator engines, nature of line, adjustment of excitation, &c.
4. Switch gear and board of the simplest possible character.
5. Flexibility of design of the plant. The best proportions can be used with motor and generator, the direct current voltage is independent of that of the line voltage, and can be varied by very simple means, by compounding, or otherwise.
6. Greater reliability when working.
7. Familiar character of the machinery and its management to the attendants.
8. The direct current side of each set being independent of the polyphase side, connections or alterations made to this side do not affect the other, and cannot possibly short-circuit the transmission lines, however much the various direct current machines or their circuits are inter-connected.
9. Less attendance is required in the sub-station, which will cost less on this account, and also because it need not be of a high order of experience.

B. *Rotary Converters.*—As the coils on the armature of a rotary converter are connected up to form a single winding, from which tappings are made to the slip rings and commutator bars, and as, with the usual windings in use, the direct current pressure has a greater value than that between the slip-rings, the ratio of the two pressures being constant for a given winding, it follows that in every case the rotary has to be connected *indirectly* with the line conductors, that is, step-down transformers have to be interposed between them and the slip rings. Each converter set will, therefore, consist essentially of the rotary converter and a step-down polyphase transformer of equal output to it, and the rotaries will always run synchronously with the generators in the power station.

Rotary converters are invariably arranged to start up from

* Even in this case, the set could easily be started from the polyphase side, by simply short-circuiting the brushes on the rings, and then switching in, but under these circumstances the starting current might be very large.

the direct current side, as, unless special provision is made for it as described below, starting from the polyphase side is thoroughly unsatisfactory. Using the former method of starting, the operation is as follows:—The compound winding (if any) on the fields having been cut out, the machine is run up to full speed as a shunt wound direct current motor. It now has to be synchronised with the line current, this being done in the usual manner by means of pilot lamps, &c., and the rotary can then be switched in. The starting resistance having been cut out, the direct current side can be connected to the direct current bus bars, and the field excitation varied in order to obtain the best effect, the value of field current allowed depending upon the conditions of working, and having no effect upon the direct current pressure. The current taken by the direct current side to start under these conditions does not exceed 50 per cent. of the full load current.

As indicated above, it is possible, but not desirable, to start rotary converters from the polyphase side. As in order to obtain satisfactory parallel running, short-circuited "damping coils" have to be wound on the pole-pieces, it is clear that it should be possible to run up the machine as a polyphase induction motor, by simply switching the slip-rings on to the low pressure polyphase bus bars fed by the step-down transformers. Under these circumstances, the polyphase currents circulating in the armature produce a very irregular revolving field, which induces currents in the damping coils, causing the machine to run up to a synchronous speed. But although the machine runs up to speed practically unloaded, the amount of starting current taken cannot be kept down, as owing to the tendency of the armature field to cog into that produced by the short-circuited coils on the poles, the torque produced with a reasonable value of current per phase is not sufficient to get the machine up to the normal speed. Consequently, the current consumption when starting under these conditions is frequently as much as four or five times the normal full load current. If the rotary is not provided with damping coils, it is still possible to start it in this way, if the pole-pieces are solid, by reason of the eddy currents induced in them, but the starting current taken in such a case is so great that it is practically impossible to employ the method commercially. It must be remembered that the large currents drawn from the lines when starting up rotary converters as induction motors, are currents of very low power factor, and may disturb the pressure regulation of the whole system, on account of the large drops they produce in the generators and transmission lines.

(To be continued.)

THE HARGREAVES-BIRD ELECTROLYTIC ALKALI PROCESS.

By JOHN B. C. KERSHAW, F.I.C.

The small works of the General Electrolytic Parent Company, at Farnworth, near Widnes, which on Monday last were inspected by representatives of the technical press as a preliminary to the public issue of the prospectus of the larger company, have twice been visited by the writer, and the following notes are based upon the observations made during those two visits, and upon the facts and figures contained in the various reports recently received from the officials of the company. It is seldom that a new chemical process is subjected to such a thorough trial as that undergone by the Hargreaves-Bird electrolytic alkali process. It is now nearly four years since Mr. James Hargreaves first described his new electrolytic cell to the members of the London Section of the Society of Chemical Industry,* and presented figures and estimates based upon 59 days' actual operations of the full-sized experimental cell at Farnworth. Since that date, almost continuous work with one large-sized cell has been carried on in these works, and many improvements in details of the cell and process are said to have been effected.

In these modern days ill-advised haste is the rule in the development of most industrial processes. Press representatives are invited to inspect working models in place of the real thing. Lack of reliable estimates is supposed by the promoters to be counterbalanced in some occult fashion by the unlimited supply of champagne and other more solid refreshments; and since the conditions for this latter supply are more easily satisfied in large cities, the show is transferred to one of the reception rooms of a modern hotel. It is therefore refreshing in these days to come across such an instance of leisurely development as that seen in the history of the Hargreaves-Bird process, and to be invited to inspect the apparatus at work, not under impossible conditions in an ante-room of a swagger hotel, as an appendage to a *recherché* luncheon, but under normal working conditions at the works of the company in South Lancashire.

This electrolytic process for the production of alkali and of chlorine compounds, and the special form of cell in which the electrolysis of the sodium chloride solution is carried out, have already been described in these columns.*

The writer has also described the works at Farnworth and the results of certain tests made by him upon samples taken from the electrolytic cell upon the occasion of his visits in November, 1897, and January, 1898, in the paper named below.† For the convenience of readers who are unacquainted with the special features of the Hargreaves-Bird electrolytic cell, it may be stated that it consists of a central anode chamber, flanked on either side by cathode chambers, which contain steam and carbonic acid gas, in place of the usual salt solution. The separating walls of these three divisions of the cell are formed by combined diaphragm-cathodes. These are impermeable to the salt solution contained in the anode chamber, but allow the electric current to pass and to carry with it the electrically-charged atoms, *i.e.*, the "*ions*," of sodium. On arriving at the outer surface of the diaphragm cathode, these sodium "*ions*" discharge their electricity, react with the steam and carbonic acid gas, and produce hydrogen and a solution of sodium carbonate.

Photographs of the cell and of the diaphragm-cathode were reproduced in the issue of the Electrical Review already named.

Turning now to a consideration of the various reports which have been made upon this process, those of Prof. Ramsay and of Messrs. Cross and Bevan contain figures which demand special attention.

Mr. A. E. Fletcher and Messrs. A. Norman Tate & Co. have also reported upon the chemical aspects of the process; while reports from Mr. J. Fletcher Moulton and Mr. G. G. M. Hardingham deal with the question of patent validity.

From Prof. Ramsay's first report, dated March 14th, 1898, the following two extracts are taken:—

1. "Careful experiments, made by me on the spot, have shown that 97·28 per cent. of the electric power is utilised in producing carbonate of soda and chlorine. I regard this as a most astonishing result."

The word "power" is used here by Prof. Ramsay incorrectly. The power efficiency of the process is most certainly not 97 per cent.

2. "It is intended, I am informed, to erect 250 cells, of which the output would be 9,488 tons a year of soda ash (if all the soda were sold in that form; of course an equivalent amount of caustic might be made), and 17,250 tons of bleach, assuming all the chlorine to be used without waste; if the usual loss of 5 per cent. is deducted, the yield would be 16,400 tons. At the present prices of bleach and soda ash the sale of these products would bring in £124,700; and the cost of the current required for their manufacture would be £33,000; leaving a margin of £91,700 to cover the cost of the other processes of manufacture, and to divide as profits.

"My experience is not sufficient to enable me to state the cost of the other processes necessary; but I think that I should leave a large margin, if I were to assume that half the margin, or £46,000, would be amply sufficient."

Messrs. Cross and Bevan follow in Prof. Ramsay's footsteps, as the two following extracts from their report dated March 22nd, 1898, show:—

1. "The theoretical yield of pure soda ash from a current

* *Journal Society Chemical Industry*, December, 1895.

* Electrical Review, August 5th, 1898.
† *Electrician*, February 18th, 1898.

of 2,294 amperes for one hour is 9·976 lbs.; the amount actually yielded during our inspection was at the rate of 9·705 lbs. From these figures we obtain the remarkable electrical efficiency of 97·28 per cent. By far the most important item in the cost of production is that of electrical power.

2. "Each cell takes a current of 2,294 amperes. The mean pressure at the dynamo when we investigated the process was 4·71 volts. At the cell it was only 3·94 volts, but even taking the higher figure, which might be considerably reduced with a large installation, we find that each cell requires 14·4835 E.H.P. At ¼d. this amounts to a total cost for power of £33,040 14s. 3d. for 250 cells per annum.

"The difference between this sum and £124,279 15s. leaves a very large margin for other charges."

The writer desires to point out that these chemists have apparently based their calculations and estimates upon observations made when the cell was working at its maximum efficiency. The efficiency of the Hargreaves-Bird cell depends upon the efficiency of the diaphragm, and, according to the inventor's statements, the normal life of each is 30 days. Commencing with a high impermeability to the passage of the salt solution, and also with a comparatively high electrical resistance, both of these characteristics slowly diminish from day to day, until a point of time arrives when the amount of salt passing through the diaphragm necessitates its removal, and substitution by a new one.

The tests made by the writer in 1897-98, and the figures supplied by the General Electrolytic Parent Company for the actual work of the cell, during two runs in September, October, and November, 1897, support this view.

These are as follows:—

Tests of Cathode Liquor.

E.M.F. at cell.	Mean sp. gr. cold.	Mean % Na_2CO_3	Mean % Na Cl.	Age of diaphragm.
...	1·125	10·90	·94	40 days.
5·4 volts.	1·094	10·44	·10	1½ days.

Details of Two Runs of the Cell in 1897.

Period of run.	Mean current. amperes.	Mean E.M.F. volts.	Salt decomposed per 24 hrs. lbs.	% Efficiency. Current.	% Efficiency. Energy.
Sept. 15th—Oct. 11th.	2,031·5	4·2	·217	92·7	50·05
Oct. 12th—Nov. 2nd.	2,089	4·24	218	90·4	48·99

These figures show that estimates of the yield of this cell, based upon a current efficiency of 97 per cent., are misleading, and that such estimates ought to have been based upon the average work of the cell during a period of 30 days, or whatever other time period may have been decided upon as the normal life of the diaphragms. If this course had been taken, the efficiency of 97·28 per cent., which figures so conspicuously in each of these reports, would have been clearly indicated as a *maximum* efficiency, and the reports would not have been open to the charge of misrepresentation which may at present be brought against them. The average *current efficiency* of the Hargreaves-Bird cell is, as a matter of fact, about 91 per cent., and the *energy efficiency* about 49·5 per cent.

The two reports would also have been more satisfactory if the probable costs of raw materials, labour, diaphragms, management, &c., had been more fully dealt with. The costs of obtaining soda ash or cryst. soda from solutions of the carbonate are fully known to chemical experts, as are likewise the costs of bleach and chlorate production. Prof. Ramsay and Messrs. Cross and Bevan, could with a little inquiry have obtained information on these points, which would have enabled them to fill up very considerable gaps in their reports.

A third point upon which these chemical experts ought to have reported, is that relating to the influence of magnesium and iron salts in the brine upon the electrolytic procedure. It has been understood that the presence of these impurities has caused the chemists at the Castner-Kellner works at Weston Point considerable trouble, and that some method of purifying the brine before it enters the cells, has had to be adopted in order to overcome the difficulty. Will this purification also be necessary at Middlewich with the Hargreaves-Bird process?

In making these remarks upon the reports of Prof. Ramsay and Messrs. Cross and Bevan, the writer has no desire to withdraw any of his earlier opinions with respect to the Hargreaves-Bird process. He still considers it to be one of the most promising of the processes for the electrolytic production of soda and bleach which have received industrial trials, and if the capitalisation of the new company be not excessive, and the management be good and efficient, he has little doubt that a financial success will be attained.

But "good wine needs no bush," and simply because the process is a satisfactory one, there was the less need for the chemical experts to base their reports upon misleading figures, or to drag into prominence a current efficiency which will not be attained under actual conditions of work.

INSTITUTION OF ELECTRICAL ENGINEERS.

INAUGURAL ADDRESS

By Prof. Silvanus P. Thompson, D.Sc., F.R.S., President.

(*Delivered Thursday, November 16th.*)

The Institution of Electrical Engineers represents not only a great and growing industry, but also an important scientific profession. Any man, therefore, who finds himself placed by the will of his fellow members in the position of president of such an Institution, may well ask himself, on entering upon his term of office as head of the profession, what are the interests of the Institution, what the most pressing needs for its development, and how he can best serve those interests or aid in that development.

In these days the advancement of science depends largely upon the mutual co-operation of scientific workers and of the societies founded for the diffusion and co-ordination of knowledge. The progress of electrical engineering, both in its industrial and its professional aspects, depends likewise in no small degree upon the combination of electrical engineers of all classes in active union. Rightly conducted, the influence of such an Institution as ours, both within and without its borders, is very great. If we speak in the name of the united profession, with the weight of the whole industry to emphasise our views, we command the respect not only of all other professional bodies, not only of other industries akin to ours, but of public bodies, central as well as local. We can influence even the administrative departments of the Government itself when considering any regulation or proposed legislation touching electrical questions.

Further, our discussions in this room have a most direct influence not only on the development of electrical practice, but on that of electrical science. To find an instance, I need hardly go further than the presidential address of Prof. Hughes in 1886, which set the electrical world discussing the effects of self-induction. The number of scientific papers read before this and other bodies during the succeeding two or three years upon the measurement of self and mutual induction is directly attributable to the effect of that remarkable address. In the electrical world, however, there are many other influences at work. Great as may be the influence of scientific societies, of the open discussion of scientific and technical problems, there are others equally potent. The prices of the materials used in our industry—iron, steel, copper, gutta-percha, India-rubber, mica—the cost of coal, the cost of water-power, the cost of transport by land and sea, the cost of labour, the technical skill and training of our designers and manufacturers relatively to those of our foreign competitors—all have the most direct influence in determining the development of the industry in one direction or another. At a time of disquietude in international politics, many of these factors in the problem may far outweigh the direct influence of our Institution. All of them will have an influence direct or indirect on us. For we flourish in proportion as the electrical industry flourishes; and as the empire flourishes, so will our Institution share in the general weal. Yet amid this complicated state of the conditions which determine the future of the electrical industry, our Institution can render real and lasting service, if by directing attention to the things which make for progress, if only by pointing out the path along which technical advances are being made or are to be made, it can assist the manufacturer, the designer, the contractor, the consulting engineer, and the capitalist, and ultimately the authorities of local and central government. There is no question but that at the present time money is being spent in this country, in many directions not to the best advantage, on electrical schemes which are ill-advised or antiquated, or too petty; that machinery is being constructed on wrong lines, to be discarded a few years hence long before its natural term of life is reached; that electrical appliances, because not made to the standards recommended by experience, are made in smaller quantities at a time, and therefore at greater expense than need be. Our Institution, by the recommendations of its Standardising Committee, has tried to prevent at least some of this waste, and it might do much more without imposing any harmful restrictions upon the freedom of a single individual. If it can point out the trend of opinion, the ameliorations resulting from experience in all parts of the world; if it can help to diffuse amongst its mem-

bership generally a knowledge of these things, and of the latest discoveries and inventions, the benefit it will confer, not only on its members, but on the industry at large, will be no small one.

I therefore propose to direct your attention to some of the tendencies which manifest themselves at present in the electrical world; some of them doubtless transitory, but others indicating changes of a permanent kind.

In telegraphy, the oldest branch of our profession, there is not much room to chronicle change. Nevertheless there is an obvious tendency to increased use of automatic methods of sending. Slowly, but surely, the use of the automatic transmitter is extending in cable service, whilst on the Continent and in America the advantages of the Wheatstone automatic are being gradually recognised as the increase of matter to be transmitted over existing landlines causes a demand for accelerated methods. It may be here recalled that the very first paper read before this Institution on March 13th, 1872, when it commenced operations as the Society of Telegraph Engineers, was on the topic of "Automatic Transmission." The use of alternating currents of a fairly high frequency is also receiving attention. Prof. Rowland has invented a multiplex typewriter working with alternate currents. The substitution of delicate optical receivers, working by photography for the purpose of enabling more rapid signals to be received, for the relays and recorders previously used, opens out a further field. Just as the limit at which the hand can send is surpassed by the automatic sender, so the speed at which the eye can read the visible motion is surpassed by that of the photographic receiver. In this connection the recent suggestions on the one hand of Squier and Crehore, and on the other of Pollak and Virág, demand careful attention. The experiments of the latter between Buda-Pesth and Berlin appear to have come as a surprise to many Continental electricians not previously conversant with the Wheatstone automatic transmitter; while the success that they have obtained in sending words at the rate of 1,300 to 1,500 words per minute over a landline of 475 miles long once more raises the familiar question whether a mile or two of subterranean cable inserted in the line would not have effectually barred the transmission and reduced it to ordinary rates. We need not believe all the nonsense telegraphed by special correspondents to the daily press from Vienna, that home of scientific canards. But Pollak and Virág's results are of more substance than the imaginary achievements of Jan Szczepanik. It is interesting to note that in their experiments success was largely due to the use at each end of the line of an inductive shunt—a device advocated so strongly for cables by our late past president, Mr. Willoughby Smith.

When we turn to the question whether such rapid methods of signalling will prove of any use on subterranean or submarine cables we are still confronted by the old difficulty that no improvements whatever in apparatus at the ends of the cable will get rid of the sluggishness inherent in the cable itself, if constructed upon the traditional patterns. The suggestion which I advocated in 1893 of accelerating the speed of signalling by attacking the problem in the middle instead of tinkering at the ends has not yet borne fruit. My suggestion to construct cables with a series of self-inductive artificial leaks of high resistance distributed all along its length to combat its distributive capacity appears to be too radical to be acceptable to the cable authorities. But it is self-evident that whatever good an inductive shunt (or artificial "leak") at the end of a cable will do in getting rid of the static charges, an inductive shunt (or artificial inductive "leak") at the middle will do just twice as much. Why, then, should the suggestion to utilise this known property at one or more points along the length of the cable not be put to an experimental trial?

Of the tendencies in the telephonic world I forbear to speak. Great Britain has little reason to be proud of her record—past and present—in that line. She allowed the microphone, freely given to the world by its too generous inventor, to be exploited as a monopoly by others.

The competition of electricity with gas as a means of illumination has been rendered very severe by the improvements introduced during recent years in incandescent gas lighting. The discovery of the properties of the rare earths in giving an augmented illumination—the result of a purely scientific research—was the foundation of the invention of the Welsbach mantle. It is singular that the very same properties were not turned to account in electric illumination before the invention by Nernst of the lamp which bears his name; a lamp for the commercial introduction of which electrical engineers are still waiting expectantly. Meantime a far more important factor in the economic struggle remains in a possible reduction of the high prime cost of electric wiring of buildings. Could electric house wiring be carried out as simply and as cheaply as the putting in of gas pipes an enormous advance might be confidently expected. But so long as our station engineers and our fire insurance inspectors insist on having both wires fully insulated, and do not allow an uninsulated or a semi-insulated return conductor, so long will this advance be delayed. With the introduction of armoured conduits for interior wiring, surely the prejudice which requires a double insulation will disappear.

In the public distribution of electric energy for lighting and power the necessities of economic working are effecting a slow but sure revolution. The methods that were in vogue at the date when the Electric Lighting Act of 1888 made electric distribution in this country commercially possible are being superseded. Larger generating units are being used in our stations. Larger areas of supply and fewer generating centres in an area are a necessity of the time. From the row of little bipolar dynamos, each with its own small high-speed engine—a sight so familiar in the older lighting stations of this country—we are gradually passing to the use of large multipolar machines coupled to larger and more economical steam engines. Ten years ago a distribution at six miles from the generating station was looked upon askance by many electrical engineers. To-day it is recognised that the secret of economical work is to generate on the large scale—"in bulk" as the phrase goes—and to distribute over large areas at an appropriately high voltage. Whether the prime source of power be hydraulic or thermal, the problems of economic distribution are essentially identical. Two of the most recent examples—both of water-power stations—must suffice. At the Kanderwerke at Spiez a pressure of 4,000 volts suffices for the distribution of current for lighting and power within a radius of six miles; but for the 30-mile distribution from the same station to supply the city of Berne and the Burgdorf-Thun railway, a 16,000-volt pressure is adopted. The city of Milan, which is lit by power from the hydraulic station at Paderno, 24 miles distant, receives its currents at 13,500 volts. When electric energy is thus generated and distributed on the larger scale, the time-honoured methods suitable for parochial areas must give way to newer ones of greater economy. Continuous current generators and motors are unsuitable for operation in such wise at economical voltages. The great superiority of alternating currents asserts itself here uncontested. And with the greater economy of copper that is afforded—in the transmission at a given superior limit of voltage—by the use of three-phase currents, commercial considerations of the most elementary order decree that the fittest shall survive. It was, doubtless, in its time a great advance when the late Dr. Hopkinson in this country, and independently Mr. Edison in America, introduced the "three-wire" system, in which by the employment of a central or neutral wire three copper conductors were made to suffice where four conductors had previously been needed. The obvious economy of using *one* neutral wire instead of *two* separate return conductors was sufficient to secure its rapid adoption. But with the introduction of the three-phase distribution we may now have three wires doing the work of six, each wire, when the circuits are equally loaded, serving as a return for the currents of the other two. In cases where, as in three-phase lighting, the three lines are not equally loaded, we may by adopting a Y-grouping with a neutral wire leading back to the common junction have *one* neutral wire serving in the place of *three* separate return conductors, thus carrying forward Dr. Hopkinson's idea to its logical extension. Experience in Heilbronn, in Strassburg, in Lyon, and a score of other places, proves that the fear formerly expressed as to difficulties in balancing the circuits is unfounded. In the light of such experience it is not premature to say that the use of the three-wire system with continuous currents is obsolete. Obsolete it is not, however, in the sense of being disused. Obsolete it is in the sense that a better and more economical method is known and is already largely in use. Of all the new lighting stations now under construction in middle Europe, quite two-thirds are designed for three-phase work. Even in Berlin, where the admirably engineered group of lighting stations on the continuous-current plan has been eminently successful, financially and technically, all extensions are being made on the three-phase plan; and in a few years the whole will probably have been converted to alternating currents.

While the continuous current is, of course, the only species admissible for electrolytic work with all its rapidly growing applications in the chemical industries, the superiority of alternating currents for motive power and for all long-distance work is every day becoming apparent. Only a very short time ago it was the fashion to decry alternating currents on the alleged ground that alternating current motors were not self-starting. That reflection might have had some weight 10 years ago. But the simple truth is that continuous currents will not work motors at all except toys of the old Barlow wheel type. Let him who doubts this statement ask himself what is the purpose of that costly organ, the commutator, which is an integral part of every so-called continuous current motor. The sole function of a commutator is to commute a continuous current into an alternating one, or *vice versâ*. If a continuous current will drive a motor, why go to the expense of putting into any motor a commutator to commute that current into an alternating one inside the machine? Moreover, the unnecessary commutator—for it is unnecessary if the currents are supplied to begin with as alternating currents—introduces the risks attendant upon the use of "brushes"—risks which have led the insurance companies to prescribe that all motors with commutators should be put in fireproof enclosures. Let it be once realised that the commutator is an unnecessary excrescence due to the supply of a particular kind of current which won't work a motor until commuted, and that, with the supply of the proper kind of current, no commutator is needed, and before long we shall see these restrictions withdrawn. A common grindstone is a thousand times more likely than a well-constructed modern commutatorless motor to cause an outbreak of fire. Yet no one prescribes fireproof enclosures around grindstones in any ordinary factory.

Another tendency of the times is the simplification of the switchboard, its construction of fireproof materials throughout, and with more room both before and behind for the good arrangement of gear and connections, and the avoidance of an unnecessary multiplication of fuses. The avoidance of step-up transformers by direct generation at high voltage is in itself an obvious step toward simplification.

In the working of alternate-current generating stations, where parallel running of a number of generators is a necessity, the station engineer has always had before him the fear of a serious breakdown should anything happen to one of the generators. If the field magnet of any one generator loses its magnetism through any failure of the exciting current, then all the other generators instantly pour an immense current through its armature, with dire disaster not only to it but to the station as a whole. All manner of devices have been designed to combat this dread eventuality. Fuses and safety-devices of every description, including automatic disconnecting gear warranted only to operate for currents in opposition of phase, are found not always to do their duty. Much discussion has arisen as to whether the excitation of alternators in parallel ought to be an excitation in

parallel, or whether each alternator ought to be provided with a separate exciter on its own shaft. Even excitation in duplicate from two independent sources has been tried. It is satisfactory to note that a means has been discovered which will entirely remove this source of anxiety, and render such accidents impossible in the future. Let me here narrate a test described in a recent number of the *Bulletin de la Société Internationale des Electriciens* (December, 1898, p. 498) upon two alternators of 250 kw. each, direct-driven at 67 revolutions per minute by two horizontal compound engines, the alternators being constructed by the well-known house of Farcot. Both alternators were separately excited, and were synchronised together and put in parallel in the usual manner. While thus running the excitation was suddenly cut off from the field magnets of one alternator, and then the steam was cut off from the engine of the other alternator, which remained excited. Both machines continued to turn, the unexcited alternator continuing the supply, furnishing current for the lighting circuit and also supplying enough current to continue to drive at nearly normal speed the other machine and its engine. This extraordinary test, repeated many times, took place in the lighting station of the town of St. Ouen. The explanation lies in the construction of the alternators. Their revolving field magnets are furnished on the plan suggested by Mons. Leblanc, with the device termed by him an *amortisseur*, which is nothing else than a simple and substantial squirrel cage of copper embedded in the pole pieces of the field magnets, each pole being perforated with six slots to receive six stout copper rods, the whole of which are short-circuited together by two external rings of copper. We are all familiar with the device of the embedded squirrel-cage construction introduced by Dobrowolsky and Brown nearly ten years ago into the so-called *rotors* of poly-phase motors. In these motors the squirrel-cage structure revolves at a slightly lower speed than that of the revolving magnetic field; and it has long been known that if the same structure is mechanically caused to revolve at a speed slightly above synchronism, the machine becomes a generator, taking power to drive it. In brief, the induced eddy currents in the copper structure, when revolved above or below synchronism, magnetise it and make it act as a field magnet. Leblanc, adapting this device to the actual field magnets of alternators, has not only simplified the operation of synchronising, but has given to the alternator the new and remarkable property that, on the failure of the excitation from the ordinary source, the automatic action of the eddy currents comes into play, and thereby entirely prevents the disastrous reactions which have been so much dreaded by station engineers. I regard this invention as one of the most important of recent years. It has been applied also to the 600 kw. alternators in the sector of the Champs Elysées in Paris.

(*To be continued.*)

THE COST OF STEAM RAISING.

By John Holliday, A.M.I.C.E.

(*Paper read November 23rd, 1899.*)

In the earlier days of the steam engine it was customary to measure the efficiency of the steam plant by the amount of work done by a given weight of coal, and this was expressed by giving the weight of coal consumed per horse-power per hour, allowance sometimes being made for the quality of the coal used. At that time, when a single boiler or range of boilers supplied steam to but one, or at most a pair of engines, and the boiler was laid down at the same time as, and as integral portion of, a new steam engine plant, and was, more often than not, supplied by the maker of the engine as part of his contract, this method of estimating was not so wholly misleading as it is in the present day, when a single boiler or range of boilers often not only supplies a large main engine, but also many auxiliary or independent ones, and also serves many other purposes. The practice has therefore arisen of expressing the efficiency of an engine by stating the quantity of steam it uses per horse-power per hour, thus eliminating entirely all questions of the quality of the fuel, the efficiency of the boiler for transmitting the heat of that fuel to the water, and of the furnace and stoker, whether human or mechanical, in evolving from the fuel all the heat it contains. In this way the performance of a good engine is not marred by an indifferent duty obtained from the boiler, from any cause whatsoever. We have therefore on record the results of many engine trials, given in figures which take no account of the performances of the boiler by which the steam they used was supplied, and we have also many recorded tests of steam boilers determined quite apart from any question of power involving the employment of a steam engine. Again, we have many instances given of the cost of steam power, the best of which are summed up by Prof. Unwin in Chapter III. of his work on the "Development and Transmission of Power;" but in all these cases, in order to arrive at the cost of the steam-power, it has been, of course, necessary to include the working and cost of both engine and boiler; and whilst a steam engine cannot perform any useful work when dissociated from the steam boiler, the boiler can, and often does, perform many useful functions other than the production of power by means of a steam engine, and it is to the cost of producing steam, quite apart from the question of power, that attention is directed in this paper. A ton of coal may cost, say, 8s. when delivered on the stokehold floor, and we may, in a general way, consider steam delivered from the boiler into the steam main as the manufactured article of which the coal is the chief but not the only raw material used in the process of manufacture; the question then becomes what is the increased value of this ton of coal when delivered in the form of steam into the steam mains? The other items which, with the cost of fuel, go to make up the total cost of steam produced, are working expenses, maintenance of boiler and plant, capital charges, rents, rates, taxes, &c. In almost all cases the cost of the fuel is by far the greatest part of the whole cost, and it can only be in the centre of the coalfields, or some other equally favoured spot, where it is probable that the cost of the fuel will be anything less than 50 per cent. of the total cost, exception being, of course, made to those cases in which waste materials, by-products, or refuse, which might otherwise have to be removed at some expense, are used as fuels for steam raising. This being the case, the cost of fuel required to convert a given quantity of water at a given temperature into steam at a certain pressure, gives a fairly relative idea of the cost of raising steam in districts where similar conditions and prices of fuels obtain. Mr. Bryan Donkin, M.Inst.C.E., has largely

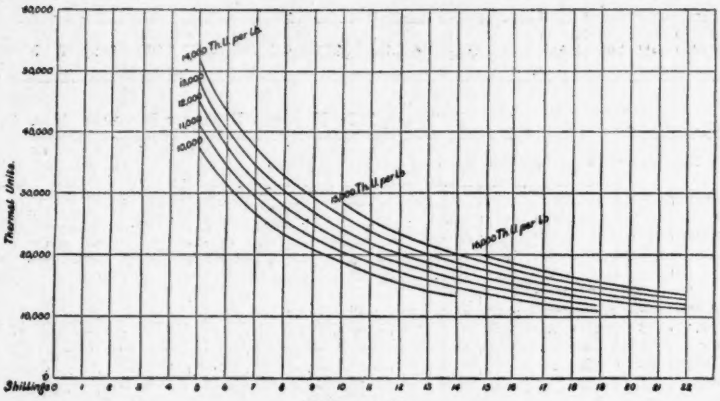


Diagram 1.

used, as a basis of comparison, the cost of fuel required to evaporate 1,000 gallons, the water being at a temperature of 60° F., and the steam evaporated at 60 lbs. per square inch above the atmosphere, or else the temperature of the water is taken at 212° F., and evaporation at atmospheric pressure, or, in other words, evaporation is from and at 212° F.; in any case a reduction to a common basis is easy when the conditions are known.

The following formula gives a ready means of obtaining the cost of fuel to evaporate 1,000 gallons of water when the price of the fuel and the quantity of water evaporated per pound of fuel are known.

Let c = cost of evaporating 1,000 gallons in shillings.
" p = price of coal per ton in shillings.
" w = pounds of water evaporated per pound of coal.

$$\text{Then } c = \frac{p}{w} \times \frac{10,000}{2,240}$$

$$\frac{p}{w} \times 4{\cdot}464.$$

This is a useful figure, especially for comparison of boilers working in the same district, where the prices of various descriptions of coals may be taken to vary with the amount of heat that they will evolve, because it takes into account the efficiency of the boiler and furnace and also that of the stoker, whether human or mechanical; but, at the same time, the limits within which comparisons may be made on this basis are narrow, as the figure would always show a very large advantage in favour of the use of poor quality and low price fuels, which a closer examination into the whole of the cost of steam raising might cause almost, if not entirely, to disappear. There will, however, be less likelihood of giving rise to misapprehensions if it be always borne in mind that this figure gives, not the cost of evaporating 1,000 gallons, but only the cost of the fuel required to evaporate 1,000 gallons of water.

Mr. Bryan Donkin, M.Inst.C.E., has published figures from some tests he carried out with different kinds of fuel in the same boiler, the conditions in all cases being the same; the results are comparable on the basis of the cost of fuel required to evaporate 1,000 gallons.

Kind of fuel.	Cost of fuel per ton.	Water evaporated per lb. of fuel.	Cost of fuel per 1,000 gallons evaporated.
	s. d.	lbs.	s. d.
A.—Dust coke ...	5 0	6 0	3 8
B.—Dust Welsh coal	10 0	8 0	5 3
C.—Large Welsh coal	22 0	9 0	10 11

These figures go far to show the economy to be obtained by using inferior fuels, which, as a rule, are far cheaper on the basis of calorific power than higher-class fuels. No better example of this could be given than the comparison of experiments B and C in the table given

TABLE II.—FORCED DRAUGHT BOILERS. NOS. 1, 2, AND 3.

Boiler.		Fuel.					Water.				Cost of fuel.	Working expenses.											
Date.	Time.	Breeze.	Large coke.	Total.	Average price per ton.	Refuse.	Evaporated.	Used by fan engine.	Net evaporation.	Evaporated per hour per boiler.		Wages of stokers and cleaners.		Fuel weighing and distribution.		Removal of refuse.		Water.		Light.		Stores.		Total.	
1895.	Boiler hours.	Tons.	Tons.	Tons.	s. d.	Tons.	Gallons.	Gallons.	Gallons.	Gallons	£ s. d.	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.	
Jan.	1,867	515	...	515	3 6	122	715,850	46,675	669,175	358	90 2 6	23 6 11		2 4 5		12 4 0		11 18 7		2 7 0		1 5 9		53 6 8	
Feb.	1,615	390	...	390	3 6	93	542,100	40,375	501,725	311	58 16 0	25 19 0		1 11 4		9 6 0		9 0 5		2 10 0		0 18 3		49 5 3	
Mar.	1,265	289	...	289	3 6	140	401,710	31 625	370,085	293	50 11 6	28 17 3		1 4 5		14 0 0		6 13 11		1 0 4		1 7 4		53 3 3	
April	1,866	443	..	443	3 6	102	615,770	46 650	569,120	305	77 10 6	24 14 0		2 12 3		10 4 0		10 5 3		1 11 0		1 0 4		50 6 10	
May	1,927	433	19	452	3 9	105	640,174	48 174	592,000	307	84 16 0	24 1 0		2 10 3		10 4 0		10 13 5		0 15 4		1 14 6		49 18 6	
June	1,315	292	...	292	3 6	96	405,889	32 875	373,005	284	51 2 6	25 1 4		0 19 9		9 10 0		6 15 3		0 13 0		1 5 9		44 5 1	
July	1,855	361	99	460	4 9½	95	701,374	46,374	655 000	353	110 4 0	15 12 5		2 10 11		9 10 0		11 13 10		1 3 0		1 6 1		41 16 3	
Aug.	1,994	344	138	482	5 2½	98	756,368	49,850	706,518	354	125 15 0	17 16 9		2 9 11		9 12 0		12 12 2		1 2 6		0 11 4		44 4 8	
Sept.	1,903	280	140	420	5 6	85	671,440	47,575	623,865	328	115 10 0	20 4 9		1 4 10		8 10 0		11 3 10		1 2 8		0 18 11		43 5 0	
Oct.	1,814	236	176	412	6 0½	79	682,856	45,350	637,506	351	124 18 0	21 19 2		2 3 3		7 18 0		11 7 7		1 1 4		2 3 4		46 12 8	
Nov.	1,838	294	12	303	3 9	92	433,030	33,450	399,580	299	84 3 6	25 4 5		1 4 7		9 4 0		7 4 4		1 5 4		3 10 11		44 2 6	
Dec.	1,840	442	...	442	3 6	102	614,330	46,000	568 330	309	77 17 0	24 10 6		2 12 3		10 4 0		10 4 8		1 15 4		0 6 8		49 13 5	
Avgs. and totals		20,599	4,316	584	4,900	4 3½	1,203	7,180,932	514,973	6,665,959	323	1,051 6 0	277 7 6		23 8 2		120 6 0		119 13 6		16 6 10		16 9 2		573 11 2	

TABLE III.—NATURAL DRAUGHT BOILERS. NOS. 4, 5, 6, 7, 8, AND 9.

Boiler.		Fuel.					Water.				Cost of fuel.	Working expenses.											
Date.	Time.	Welsh.	Scotch.	Total.	Average price per ton.	Refuse.	Evaporated.	Evaporated per pound of fuel.	Evaporated per hour per boiler.		Wages of stokers and cleaners.		Fuel weighing and distribution.		Removal of refuse.		Water		Light.		Stores.		Total.	
1895.	Boiler hours.	Tons.	Tons	Tons.	s. d.	Tons	Gallons.	Pounds	Gallons		£ s. d.	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.	
Jan.	2,351	487	...	487	14 6	47	892,320	8·18	380		353 1 6	23 8 2		2 2 (		4 14 0		14 17 6		2 19 0		0 14 3		48 14 11	
Feb.	2,234	408	...	408	4 6	48	819,592	8 97	367		295 16 0	26 13 0		1 12 9		4 16 0		13 13 0		3 9 0		0 13 3		50 17 0	
March	2,944	536	...	536	14 6	70	1,103,084	9·18	375		388 12 (	23 17 5		2 5 4		7 0 0		18 7 8		3 11 0		2 1 4		57 2 9	
April	2,296	436	...	436	14 6	49	869,596	9 11	387		316 2 0	29 19 4		2 11 6		4 18 0		14 16 6		1 18 8		0 15 1		54 19 1	
May	3,034	525	...	525	14 6	54	1,098,106	9·34	362		382 12 6	16 19 4		2 18 3		5 8 0		18 6 0		1 3 6		1 13 7		46 8 10	
June	3,005	492	...	492	14 6	52	1,084,922	9 84	361		356 14 0	14 16 11		1 13 4		5 4 0		18 1 7		1 10 0		1 15 1		43 0 11	
July	3,135	526	86	612	14 3½	72	1,381,211	10·07	440		437 13 (	25 3 2		3 7 8		7 4 0		23 0 5		1 15 2		1 9 5		61 19 10	
Aug.	3,282	587	...	587	14 6	72	1,343,916	10 22	409		425 11 6	32 4 6		3 0 9		7 4 0		22 7 11		1 17 0		0 7 8		67 1 10	
Sept.	3,399	609	...	609	14 6	73	1,345,900	9·86	396		441 10 6	22 2 5		1 15 11		7 6 0		22 8 7		2 0 4		1 0 2		56 13 5	
Oct.	3,409	619	...	619	14 6	71	1,360,745	9 81	399		448 11 6	31 11 0		3 5 0		7 2 0		22 13 6		2 0 0		2 17 8		69 9 2	
Nov.	3,266	440	70	510	14 3½	71	1,232,619	10 80	377		364 17 0	16 8 6		8 6 1		7 2 0		20 10 10		2 11 4		3 6 7		58 5 4	
Dec.	2,702	332	156	488	14 0½	66	1,035,130	9 47	383		342 18 0	25 8 9		6 0 9		6 12 0		17 5 0		2 12 0		0 2 1		58 0 7	
Avgs. and totals		15,057	5,997	312	6,309	14 5½	715	13,594,141	9·62	388		4,553 19 6	288 12 6		38 19 4		74 10 0		226 8 6		27 7 2		16 16 2		372 13 8	

above, where we see that a difference of 120 per cent. in the price of the fuel gives an increased efficiency of but 5·5 per cent. at an increase in cost of 108 per cent. Should it be possible in practice to transfer the total heat of a fuel to the water contained in the boiler in the furnace of which the fuel is burned, or even a fixed and definite portion of the total heat, then the true value of that fuel for the purpose of steam raising would depend directly on the calorific power, and it would be possible, the price of the fuel and its calorific value being known, to foretell the amount of useful heat that would be secured by the combustion of one pennyworth of the fuel in question.

A table showing the number of thermal units in one pennyworth of fuel of various qualities and prices was given by Mr. R. E. B. Crompton, Past-President, in his paper on the "Cost of Electrical Energy" read before this Institution in April, 1894, which is, by permission, reproduced in Table I.*

Some figures from this table will be found set out in Diagram I. These, like the preceding table, show the enormous advantage promised by the use of low quality and low priced fuels, but, as there never was a gain without some loss, we may briefly inquire what the possible losses and disadvantages of cheap fuels are—and they are many.

In the first place, in order to get the same amount of heat with a low quality fuel as with a higher quality under similar conditions, more fuel must be burned in the same time; then, if the boilers and furnaces are already working up to their full power, either more boilers and furnaces must be put down, or the present furnaces must be enlarged, entailing an expenditure of capital, the interest of which must be set against the extra economy obtained; or else the fires must be worked harder, perhaps by the use of forced draught causing the furnace gases to leave at a higher temperature, and thus carry to waste a larger proportion of the heat in the fuel than formerly. The mere fact of more fuel having to be fired into the furnaces every hour will entail more work on the stoker, for which extra wages will have to be paid either to the same or to additional men. The extra amount of fuel used will cause the fire doors to be opened, in the case of hand-fired furnaces, more frequently or for longer periods both for firing and for cleaning fires, whilst the extra amount of refuse taken from the furnaces will carry to waste a correspondingly larger amount of heat, and, what is of more importance, will often cost a great deal more in removal, particularly in busy manufacturing centres. Extra storage and space for fuel may have to be provided, and the wear and tear of the furnaces increased according to the extra amount of fuel used, and not according to the amount of steam produced. Low quality fuels, too, as a rule, require a stronger draught to burn them to the best advantage than better qualities; this may necessitate an expenditure for more chimney power in the case of natural draught, and larger fans and engines, of course using more steam to drive them in the case of forced draughts. In substituting inferior for better-class fuels we may expect a reduction in the cost of the fuel, depending on the differences in the ratio of calorific value to price of the two fuels, and an increase in working expenses, &c., depending on the increased amount of fuel used.

It may not be out of place to give here a word of warning to those who are invited by the manufacturers of special furnaces to enter into contracts with them, in virtue of which the manufacturer of the patent furnace shall take as his remuneration for fixing the furnace, free of charge or at cost price, a definite proportion of the ascertained saving in the fuel bill from the time the new appliance was put in, as compared with a previous period; such an arrangement may seem very fair and reasonable; but if the reduction of the fuel bills is accomplished by the use of inferior fuel, there must inevitably be increased incidental expenses, the whole burden of which will fall on the steam user, and from which the furnace manufacturer will be entirely free. Still more to be deprecated is any arrangement based on a comparison of the amount and cost of fuel consumed on two trials, one made before the introduction of the special appliance, and the other after it, for in addition to other disadvantages to the steam user, it is reasonable to assume that the furnace manufacturer will take pains to secure those conditions under which his furnace works best, whilst a furnace about to be discarded is scarcely likely to be either in the best possible order, or worked to the best advantage; indeed, it is safe to say that the vaunted superiority of many a special appliance over the ordinary furnace, whatever that may be, is attributable mainly, if not solely, to the better conditions obtained for it, and the greater skill with which it was worked, and with a reversal of these conditions, the result may have been reversed also.

It sometimes happens that a single range of boilers has to supply steam to a number of more or less different and independent concerns, each of which has to bear its own share of the expenses of producing the steam it uses, so that it becomes necessary to determine the total cost of the steam produced and divide that sum amongst the different

* Table I. is not reprinted here, as it will be found in ELECTRICAL REVIEW, April 27th, 1894, page 499, in Mr. Crompton's paper.

concerns as nearly as possible according to their respective consumptions. This has been the case with a range of boilers in which the author has been directly interested for the last six years; failing to find any records of determinations of the proportion which the fuel bill bore to the total cost of the steam delivered into the steam main, he has collected the data on which the following statements of costs have been made out.

The plant consists of nine Lancashire boilers in the main boiler house, and four spare boilers in another house, connected to the same system of steam mains, but the latter used only as spare to the nine boilers in the larger house. The nine Lancashire boilers are of various makes and ages, none of them being modern, and vary in size from 6 feet 6 inches to 7 feet in diameter, and from 28 to 30 feet in length. They are arranged in two groups, Nos. 1, 2, and 3, being fitted with Perret's water-cased grates for burning inferior fuels and delivering their products of combustion into a separate main flue and chimney from the other six, which are fitted with ordinary bars and hand fired, Martin's balanced doors being used in the 12 furnaces of these six boilers. The boilers are all loaded to 60 lbs. pressure per square inch, and feed water is delivered to the Lancashire boilers from a common feed main through three steam heaters, which, being

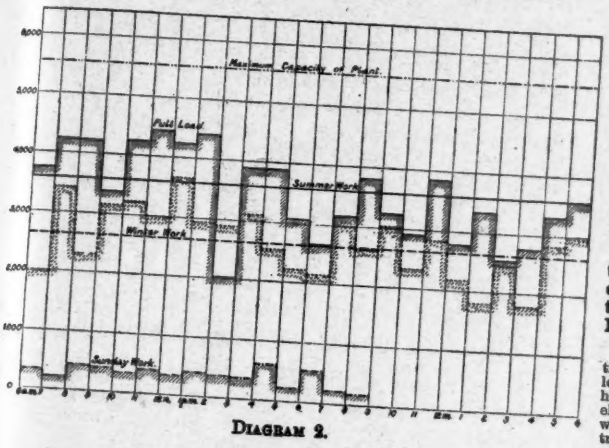


Diagram 2.

supplied with steam up to 12 lbs. per square inch above the atmosphere, heat the feed water to an average of 220° F. after it passes the feed pump on its way to the boilers. The demand for steam is fairly constant during the 24 hours (see Diagram No. II.), so that it is not necessary to bank up any of the fires during any portion of the day or week, except between 6 o'clock a.m. and 6 o'clock p.m. on Sundays, when two boilers only are kept under very easy steam.

In working these boilers it has all along been recognised that steam was produced much more cheaply by the forced draught than by the natural draught furnaces, consequently they were always worked up to their full power, and as the minimum demand for steam almost exceeded, except on Sundays, the amount they, by themselves, were capable of producing, they were seldom even damped down, and therefore worked under conditions extraordinarily favourable to economy; whilst the natural draught furnaces, having to make up the difference between the demand for steam and that produced by the forced draught furnaces, being fitted for that purpose with an automatic damper, were constantly varying between partial and full load, so that losses by unconsumed gases and radiation were abnormally great. This fact must be kept in mind, and allowed for, in comparing the results obtained in the two systems, and it will be seen that the six boilers fitted with natural draught furnaces gave much better results when doing the largest amount of work.

During seven months of the year seven boilers working together are able to supply the demand for steam, but during the later summer and autumn months the requirement is much greater, and nine boilers have to be worked heavily, and sometimes even more, which fact justifies the existence of the four reserve boilers which might otherwise constitute an extravagantly large spare plant.

The fuel generally used for the boilers with Perret furnaces is breeze, which is delivered in front of the boilers at the price of 3s. 6d. per ton. This fuel contains a large amount of incombustible material from 22 to 25 per cent.; the amount burnt is about 15 tons in 24 hours, or 1,400 lbs. per hour, or 18 lbs. per hour per square foot of grate surface, the total area of the six furnaces being 78 square feet, and evaporate from 5·5 to 6 lbs. of water per pound of fuel; taking this at 5·8, the cost of fuel to evaporate 1,000 gallons is, by the formula given above:—

$$C = \frac{P}{W} \times 4\,464$$

$$= \frac{3\,5}{5\cdot8} \times 4\,464$$

$$= 2\,69 \text{ shillings} = 2\text{s. } 8\tfrac{1}{4}\text{d.}$$

The quantity of water evaporated is about 3,400 lbs. per hour per boiler, equivalent to 170 H.P. at 20 lbs. of steam per horse-power per hour, a low result which eventually makes itself felt as one of the drawbacks to the use of inferior fuels. There being a plentiful supply of this breeze, it has been used almost invariably during the period of these observations for these three boilers, other fuels being tried at various times, but none were found able to compete with it. The air pressure used for the Perret furnaces averaged about 1·1 inches of water column as measured under the fire bars, and was produced by a 36-inch fan driven by a belt from a special engine, the steam for which was taken from the boiler, and its amount is included in the figures given above, but for which due allowance is made in the proper place, both for the cost of the steam used and the interest on the capital sunk in the fan engine and other special appliances.

(To be continued.)

LONDON COUNTY COUNCIL.

The Council, at the meeting on Tuesday, resolved to lend £50,000 to the Hackney Vestry for electric lighting purposes at 3¼ per cent., no repayment of principal to be made during the first three years, but the whole sum to be repaid in the remaining 39 years out of the 42 years. It was also decided to advance £3,110 to the Poplar District Board for the purchase of site for an electric light station.

It was decided, at the request of the chairman of the Highways Committee, to again postpone for a fortnight the report dealing with the United Tramways Company, in order to allow the Hammersmith Vestry to place their views before the Council.

Electric Tramways.

The adjourned report of the Highways Committee was again submitted recommending the Council to seek powers in the London County Tramways Bill for sanction to reconstruct for electric traction the tramways between Westminster Bridge and Tooting, and between Blackfriars Bridge and the "Horns" public house at Kennington.

A report was submitted by the Finance Committee dealing with the financial bearings of the proposal of the Highways Committee to obtain powers in a Bill to authorise the use of electric traction on the Westminster Bridge-Tooting tramways, and on the lines between Blackfriars Bridge and Kennington Park. The committee stated:—

It has been assumed in previous calculations as to the financial aspects of tramway and light railway schemes that the traffic receipts will amount to at least as much as the present average receipts per mile run for the system of horse tramways, viz., 10½d. per mile, and that the expenses of working by electric traction will be 6d. per mile. These figures show an estimated profit on working of 4½d. per mile run, and the average profit on working the present tramways is about 3d. per mile run, so that the estimated saving in working expenses as a result of adopting electric traction is 2½d. per mile run. The number of miles run over the lines which it is proposed to convert is stated by the tramways manager to be upwards of 2,070,000 per annum. The mileage at 2½d. per mile equals about £21,500, and this figure, therefore, is the extra profit which the Council may look for as a result of the conversion. Out of this will have to be paid the charge for interest on and repayment of the capital cost of conversion, which is estimated at £271,200 (including equipment). From this, however, may be deducted the estimated value of old materials arising from the dismantling of the existing lines, £15,750, leaving a net capital outlay of £255450. From inquiries which we have caused to be made as to what has been done in other towns where powers have been obtained for the conversion of horse to electrical traction, we think the Council would probably be able to obtain the consent of the Treasury to the whole cost of conversion being charged to capital account and being spread over the Council's short period term of 25 years. We have promised the chairman of the Highways Committee to consider whether repayment can be spread over 30 years. Assuming the period of 25 years for the repayment of the total outlay, and taking the rate of interest at 3 per cent., the annual charge for debt would be £17,882, leaving a margin of extra profit as a result of the conversion of £3,618 a year. This would gradually increase as the debt is paid off.

The Chairman of the Highways Committee having moved the adoption of the recommendation,

Colonel Ford said there was a very strong feeling in the South of London that the experiment proposed should not be carried out in one of the busiest parts of London, and he appealed to the chairman as to whether there was not some less frequented spot where the trials could be made. As an amendment the speaker proposed that the application to Parliament should be subject to the consent of the local authorities being obtained to the experiment being made, but there was no seconder.

Mr. Gilbert, in reference to the proposed Blackfriars section, asked the chairman of the Committee whether it would not be possible to extend the line from the "Horns" public house to the junction of the cable tramways in Brixton Road. If the electric line were not extended in that manner, great public inconvenience would be caused, since it would be necessary to work the 200 yards of track between the "Horns" and Brixton Road by means of horse traction.

Mr. J. W. Benn, in reply, stated that the difficulty suggested by the hon. member would be overcome by the general powers being sought by the Council in the ensuing session in order to transform the whole of the undertaking to electric traction.

The recommendation on being put to the meeting was then adopted.

Light Electric Railways.

In a further adjourned report the Highways Committee recommended the Council to approve the draft of the Deptford, Shooter's Hill, and Woolwich light railways order, and to authorise the Committee to settle the orders in substantially the same form with regard to the proposed light railways (1) between Clapham and Kingston Road; (2) New Cross and Eltham; and (3) in Archway Road, Highgate.

Mr. Melville Beachcroft expressed the opinion that whether the application was successful or not there should be no mistake about the form of the order. The specimen order prepared by the solicitor and the draft order had contained a clause which would have enabled the Council on the completion of the lines to have leased them to a company, if it was considered desirable to do so. Unfortunately, there were narrow-minded members on the Committee who

thought there would be danger in introducing a clause of that nature into the order in question. The decision of the Committee to override the advice of the solicitor was only carried by a narrow vote, and the result was that the order did not contain the particular clause. He thought every right-minded councillor would agree that whether it was the intention of the Council to lease the lines or not it was advisable that the clause should be embodied in the order. The Highways Committee had resolved to recommend the clause in the case of the Archway Road, Highgate, line, and it ought to be included in other schemes. As an amendment, the speaker proposed that a clause should be inserted in the order giving the Council power, similar to that contained in the Tramways Act, of leasing the lines at any time found to be desirable.

Dr. Longstaff, in seconding the amendment, said that the modest proposal should commend itself to everyone.

The Chairman of the Committee stated that the question had been carefully reviewed, and that the Committee had come to the conclusion that it was better to go before the Commissioners as a municipality desiring the powers and desiring to work the railways. Some of them were of opinion that the Council would stand a better chance of obtaining the orders in that manner than by appearing before the Light Railway Commissioners with another form of order. The Committee had also arrived at the conclusion that the leasing of tramways had been weighed in the balance and found wanting.

Mr. T. B. Westacott mentioned that not a single light railway order had been granted which did not contain the clause providing for the leasing of the railways.

After further discussion, a division was taken on the amendment. There were 41 in favour and 65 against. The amendment was, therefore, rejected, and the recommendation of the Committee was then adopted.

Asylum Lighting.

The Asylums Committee stated that in course of time there would be several asylums on the Horton estate, comprising 1,060 acres, and that they were of opinion, instead of each institution having its own separate plant for the supply of the electric light and water, that it would be more economical to erect a central station for those purposes. Three schemes had already been under consideration, but the Committee were not prepared to recommend the adoption of any one of them. The engineer was engaged in drawing up another scheme, which, it was hoped, would be submitted to the Council by the beginning of next year. The Committee accordingly recommended the Council to approve the principle of a central station for the supply of water and electricity, and to authorise them to bring up a scheme for that purpose.

MARCONI TELEGRAPHY.

The improvements which Mr. Marconi has made in his system of wireless telegraphy, appear to be rapidly increasing its efficiency and extending its range. One of its recent achievements is graphically described by Major Flood Page in the *Times* of the 18th inst. Before Mr. Marconi left New York he cabled to the office of his company in London that he would speak to the Needles (where there is a Marconi installation) from the steamship *St. Paul*, on her arrival in English waters. The telegraphists were in attendance at the Needles station for some hours before the vessel was expected, and in due time their anxiety was relieved by the ringing of the bell. "Is that you, *St. Paul?*" "Yes." "Where are you?" "Sixty-six nautical miles away." The exchange of telegraphic messages was continued while the vessel passed along. Messages were sent by passengers to be forwarded to many parts of England and France, and the latest war news was communicated to the ship where it was published, in the *Transatlantic Times*, which was printed by the ship's compositor, and sold at a dollar a copy, for the benefit of the Seamen's Fund.

That vessels within 70 or 80 miles of land, can communicate with the shore by wireless telegraphy with the greatest ease and certainty, has now been established by Mr. Marconi, and in this field alone there is likely to be considerable employment for the Marconi apparatus. But what is still more urgently wanted is some means of enabling vessels to ascertain the direction in which the etheric waves come from, say, a lighthouse or another vessel. By this means a vessel in a fog might ascertain its position and avoid collisions and shipwreck. According to the *New York Herald*, of October 10th, Mr. Marconi appears to have already attained some success in this direction by the use of deflectors. Mr. Marconi is represented as saying "In the very near future I will have ready what is known as a deflector. By means of the deflector, ships will be able to make their way through fog and storm to safety. In England, lighthouses are already using wireless telegraphy. My plan is to have all ships equipped with signalling machines and deflectors. It will then be possible to send the signalling currents all in one direction, instead of broadcast as is now done. The deflectors will be revolved about the mast, and as the currents reach the point from which they are sent to the receiver, an indicator will ring, and the pilot may steer his vessel along a safe course, being guided by signals from the shore."

We have for some time heard a good deal about these deflectors. In only one instance have we any record of their having been successfully used. When Mr. Marconi undertook to report the yacht races for the *New York Herald*, he conceived it possible that the spirit of journalistic rivalry might lead to an attempt to interfere with the communication which it was his aim to establish. Some attempt appears actually to have been made either to tap the Marconi waves or to create an etheric disturbance which would obliterate the Marconi messages. This is said to have been defeated by Mr. Marconi "by an ingenious arrangement" — probably some arrangement of deflectors.

Theory hitherto has condemned the successful use of metal plates, either as deflectors or reflectors, and there is at present little faith among the experts in this idea. Mr. Marconi has already, however, accomplished so much, often in defiance of theoretical predictions, that he may yet succeed in directing his waves in a definite direction, or in ascertaining the direction from which they come, to the receiving station.

The naval authorities of the United States Government, after witnessing a demonstration by Mr. Marconi between the cruiser *New York* and the battleship *Massachusetts*, have become convinced that the system can be utilised with immense advantage in naval warfare. It is intended to introduce the system into the United States Navy, and it is proposed, in the first place, to establish it between Key West and Cuba.

At the request of the War Office six of Mr. Marconi's assistants have started for Cape Town, whence they will go to Durban to assist Sir Redvers Buller. The plant is similar to that tested so successfully in the last naval manœuvres. The plant might be of immense value in military operations after it has been thoroughly tested and adapted for this use, but it is not likely that the present apparatus will stand the knocking about that it will be subjected to in the field. The beleagured garrisons in South Africa are apparently not supplied with Marconi plant. The system of telegraphy by earth currents, suggested by Dr. Lodge in the *Times*, might be of use in an emergency, and certainly deserves the attention of military telegraphists.

A TENDER POINT.

On the question of inviting tenders for electrical plant, it is now a frequent practice with corporations to postpone their decision to the last moment; indeed, although the matter is often under consideration for years before any definite steps are taken, months only are granted to the contractor to complete, in many cases, heavy contracts, as councillors, in their desire to see the installation for which they have had part in voting the credit, completed during their own term of office, leave too little time for the manufacturer to make and erect the plant. Of course, it would be possible for the manufacturer to make the plant in advance as stock, provided that some standards were agreed upon by consulting engineers, but in the present state of the profession, this appears to be too much to expect. Assistance to manufacturers would, however, be given if more time were allowed for the preparation of tenders, and if facilities were afforded for the getting out of estimates. In the present state of affairs the time is often limited to a week or ten days, and only rarely is a month allowed, although it is evident that if the plant is of any importance, and any drawings are required, one month is certainly not too much. Again, it is the practice of some of our consulting electricians, when the tender is divided into sections, to include in the dynamo section so many accessories of which the electrical contractor is not a maker, that a great deal of work is entailed on him in the obtaining of tenders from sub-contractors; indeed, it is not uncommon that in this section

the value of the electrical work is much less than half the total of the tender. The reason that the electrical contractor has to do this work is that if he refuses another will accept, whereas the engine makers, who occupy a more independent position, decline entirely to tender under such conditions.

If the consulting engineer is not himself prepared to take the trouble to split up the tender form into more sections, at least he may aid by asking for less detailed information with regard to accessories, and by stating in round figures the allowance that should be made for these extras, leaving the settlement of detail until he is brought face to face with the successful tenderer. Of course it is obvious that if he can get contractors to tender for the whole of the machinery section, it saves the consultant much time; but if he passes what is, after all, his own work on to other shoulders, he should give more time for carrying it out. Another difficulty of less importance is, that generally only one ordinary copy of the specification is handed to the tendering firm, and it is necessary to prepare copies so that tenders may be invited from possible sub-contractors; this means a loss of two or three days, as often the specification is a document of 80 or 100 pages. Would it be too much to ask the consulting engineers to adopt some plan that would obviate this loss of time? In a recent tender the plan adopted by the War Office, due, we believe, to Capt. Baylay, R.E., seems a good one, and met the beforementioned points; the specification was provided in the ordinary way, and, as far as possible, the sections were so divided, that each section could be dealt with completely by one contractor; thus it became unnecessary to type the copy for sub-contractors, and as the various schedules of prices and particulars were printed in copying ink on a sheet with perforations for ready detachment, it was only necessary to detach the schedules and tender form, and after press copying, forward them, retaining the specification, and, of course, the press copy. The War Office thus had all the particulars it required, and the contractor all that he wanted, without loss of time and unnecessary expense.

It may be considered that any such plan is a detail of little importance, but it must be borne in mind that it is only by attention to such detail, in many cases occupying 20 per cent. of the time allowed, that we can hope to get work planned and executed in the short time available.

CORRESPONDENCE.

The Board of Trade and Electric Tramways.

Your article, "The Board of Trade and Electric Tramways," is indeed interesting, and having had most of these difficulties to contend with as resident and consulting engineer to the Madras Electric Tramways, I trust you will see your way to publish the following:—

Trolley poles at present are not by any means perfect, and the various tramway engineers have yet to find out some of their little peculiarities, such as tearing down pole arms, overhead wires, guards, pullovers, span wires, &c., and as many of the designers and engineers have had no previous practical experience in traction work, one must expect accidents.

I will leave the trolley pole alone in this letter, but will endeavour to treat same at some future date. I am led to understand from your article that with the "Dickinson" system, span and pullover wires are not used;* this, of course, is a slip on your part, as these are essential on curves, at which points a trolley is most inclined to leave the overhead wire, and from my experience it is advisable to have all pullovers and cross-wires insulated at both ends, and not earthed as suggested by Mr. Trotter.† I can endorse all Mr. Trotter says regarding centre poles; not only are they a nuisance to drivers of vehicles and traffic in general, but a source of great danger to passengers who will alight when the car is travelling, and invariably run foul of the centre pole. Of course, this could be avoided, assuming you have width of street for two vehicles to pass each other on both sides of track, and 4 feet clearance from car to centre pole. The in-and-out motion of traffic is very much to be avoided.

* We did not say so.

† Mr. Trotter referred to the *guard* wires.—Eds. Elec. Rev.

I am glad to see you have drawn attention to the long arm brackets, which are unsightly, distinctly weak, and dangerous.

I am sorry that I cannot fall in with your idea that 500 volts are dangerous. I have seen many cases in which a cable has dropped upon a group of Madras natives, with their scanty wearing apparel and bare feet, with no more serious result than a bit of a fright; in fact, it acted rather as a tonic.

Guard wires of various kinds are, no doubt, a necessary evil, and having carried out a great many experiments in conjunction with the Madras Government telegraph engineers, I am inclined to think it possible to design guard wires to avoid almost all risk of contact; at the same time, this can be done with greater efficiency, and be much more sightly, by the telegraph or telephone companies, at the tramway company's expense, binding off their line wire, and running a larger gauge over the track, as required by all railway companies, in crossing their lines. A light fuse could be inserted joining up span wire to line wire, insuring in case of accident no damage to telephone or telegraph instruments. Under the span wires, from an arm extending some little distance further out, could be run two light guard wires, parallel to the span line wires, with bridge pieces of the same section of wire, running at right angles about every 6 feet. By such an arrangement I have found from practical tests that it is almost impossible for a telegraph or telephone wire to drop to earth, as these wires are out of the line of sight, it is by far the most satisfactory plan.

I beg to differ with you in your answer to "Working Electrician," and contend that experience in engineering is not essential in the erection of traction plant. All that is necessary is, that you have served a pupilage of three years, minus black time—counting number of hours worked would be almost a total of 12 or 18 months at most, at the end of which the said pupil of wide and varied experience requests his firm to pay him in accordance with his abilities. They make him a large and handsome offer of a salary of from £20 to £40 per year, which, in many cases, he cannot think of accepting, as it is so charitable of his late employer to so accurately appraise his real value. A few months after he is again to the front, having a relation or friend in one of the municipal corporations, he is installed as resident electrical engineer, and at once prepares electric light and traction schemes, and endeavours with the help of the said Corporation or committee (who, as we all know, are born electrical engineers) to carry out these schemes.

Then the faults crop up, and the poor ratepayers have to pay, pay, pay, for this absent-minded beggar, who, of course, blames his contractors, and is ably supported by the rest of the born engineers. I hear on good authority that in the near future they intend making electrical engineers, in which case you will, no doubt, use all the influence of your valuable paper in the furtherance of such an excellent scheme.

F. S. Hanning.

Arithmetic of Electrical Measurements.

I have had the Electrical Review for the past 15 years, and saw the review of the seventh edition of my little book on "Electrical Measurements" in the issue of October 27th, p. 668.

As a general rule I never reply to reviewers—like Madame Correlli, I ignore them—I should not do so now had not the publisher called my attention to the par., and that since then I have received a cutting anonymously.

The first 13 lines simply express the opinion of *one* individual—your reviewer.

The fact that the seventh edition is now being issued, and that also that the book has been translated into German and commands a large sale in Germany, are proofs that I also have an opinion, and that my opinion as to what is necessary for "young students in electrical measurements" is not only respected, but, moreover, valued.

Your reviewer says, "Minotto is as usual spelt wrongly Menotti." If it be usual to spell it Menotti, whence his authority for "Minotto?"

Again, "He would not be sorry to see a text-book issued which ignored the existence of primary cells altogether."

F

This is a desideratum only to be accomplished when there is no demand for them, and when such huge establishments as the Post Office Telegraph Department and the telegraph and telephone companies throughout the world cease to use them.

The misprint + for × on p. 52 had already been noticed, but as you yourselves, on p. 671 of this same issue, October 27th, 1899, "*regret unfortunate slips*," so do I, and the misprint will be corrected in any future issues.

Your reviewer would do well to study the synonyms and idioms of our English language before again indulging in the strain of sarcasm underlying his allusion to my expression "constant variation."

Had he consulted Webster's, Walker's, or Worcester's dictionary, had he studied the utterances of our greatest orators, he should have known that this phrase, though apparently paradoxical, is perfectly consistent, and quite allowable in the sense in which I have used it.

But it is a great pity he concluded by showing a want of knowledge of electrical terms in common use, by sneeringly remarking that on p. 110 I mention "conductivity resistance," *whatever that may be.*

I may be considered an ignoramus for using such a term, but I can assure your reviewer he can place Lord Kelvin, Sir W. H. Preece, and Mr. H. R. Kempe in the same category. They, in common with several well-known electricians, repeatedly use the term.

I have neither time nor desire to enter on any controversy respecting such trivialities, but having been the editor of a journal for some years, I certainly should advise you, in future, to criticise the criticisms of your satirical critic.

If the ELECTRICAL REVIEW is to maintain its previous high reputation, it will be well to note that such expressions as I quote will not tend to do it—p. 683. Prof. C. A. Carus-Wilson writes:—"In your criticisms of my letter *you ridicule Mr.* Barlow, &c."

In your current issue, p. 792, you have to explain to a correspondent, "*There was no ridicule in our note*," &c. P. 795, "*If we have hurt the feelings* of the Barnsley Town Council," &c. Again, p. 796, "*Far from ridiculing* them (the Berrenberg Syndicate)," &c. Three semi-apologies in one issue show something must be amiss at your head-quarters.

Wm. R. P. Hobbs.

H.M.S. *Vernon, November 22nd*, 1899.

[We must congratulate Mr. Hobbs upon his relations with Lord Kelvin, Sir W. H. Preece, Mr. H. R. Kempe, and "Madame" Corelli (with one *r*); we await their comments. We point out misprints whenever we come across them, merely for the assistance of the author in issuing his next edition, and of the readers of the present one. The spelling of Minotto we had many years ago on the authority of the engineer of the Italian Telegraph Administration. Mr. Hobbs has apparently misread "conductor resistance," a common and correct expression, as "conductivity resistance," an absurd contradiction in terms, and we may say that Mr. Kempe has now abandoned "conductivity resistance" for "conductor resistance." We entirely deny Mr. Hobbs's assertion that the three quotations at the end of his letter were semi-apologetic, although we are always prepared to make reparation if we are in the wrong. Finally, we prefer to think that if anything is amiss, it is in the "head" quarters of our irate correspondent himself.—EDS. ELEC. REV.]

Signalling Without Contact.

In your current issue is a letter, signed "C. M. J.," which demands a reply from me. The letter bristles with questions, answers to which will emphasise some of the strong points of my system; but it will be evident that a gentleman who demands "a nearer approach to absolute certainty than may be attained by fallible humanity" will not be easy to satisfy.

"C. M. J." commences the attack by stating that when a driver in a fog passes "fixed signals *which cannot be seen*" (the italics are mine), he "assumes" they are "at danger"; it would be interesting to hear by what sense he discovers or assumes that they are *there*. Moreover, if a driver knows by inspiration when he is passing an invisible signal post, and assumes the signal to be at danger until he makes out a fogger with a green lamp or flag, of what earthly use are the detonators?

As to Sir George Findlay having "written in the highest praise of the results attained," the question is: What bearing has this on the discussion of a new apparatus? Plenty has been said, and justly said, in the highest praise of the old millwrights' work with hand tools, but that is no reason for discarding modern machine tools.

"C. M. J." suggests the use of an invariable danger signal except when an "all right" signal has to be given. This can easily be arranged if desired, and, as I say in my paper, the form of signals is a subject for discussion. To me it seems that the idea of running with your signal on is quite wrong: the indicator on an engine necessarily gives, not the signal you are coming to, but the signal last taken, and under which you are running. Possibly, in order to show still more clearly that this is what is being done, it might be well to construct the indicator to show a back instead of a front view of the two semaphores.

The "danger signal and an all right signal in quick succession" as proposed by me form practically *one* signal to be read after the arm is stationary, a short ring on the bell having called attention to the receipt of a fresh signal. It is difficult to see where the confusion comes in.

"C. M. J." asks, in regard to the danger signal, "Can no circumstances be conceived in which his danger signal would not be invariable?" When "C. M. J." has arranged that under no conceivable circumstances can a rail, a tyre, an axle, a detonator, or a letter-writer fail, I shall be happy to discuss the question of absolute perfection in signalling on the engine also.

As to whether detonators or relays are the more liable to failure, that is a matter that can only be determined by a large experience of both. If "C. M. J." had had my experience he would have more faith in the armature relays than he appears to have.

The permanent road magnets undoubtedly do retain their magnetism for a very long time—how long I cannot say. If it should prove necessary, they can very easily be remagnetised at long intervals *in situ* by passing over them a suitable electro-magnet hung from a trolley pushed along the line.

I fully admit that simplicity is, to some extent, a matter of opinion, and I must leave each individual to form his own. I may, however, point out that in the discussion of my paper, Mr. W. A. Price, M.A., who has had wide practical experience with electrical apparatus, described the parts of mine as being "extremely simple." Mr. Swinburne has said of my system "It is in the very nature of things much simpler and cheaper than the present semaphore system." I certainly attach more importance to the deliberately expressed opinions of such men as Mr. Price and Mr. Swinburne than to the lucubrations of an anonymous correspondent.

"C. M. J.'s" statements that my apparatus "would practically convert the cab of the engine into a signal box," and that "the driver of an express train would require a man to attend to the signalling apparatus" are not worth controverting; but it may interest "C. M. J." to hear that the fitting of the apparatus on the Great Northern engine was carried out at high pressure, under my direction, entirely by engine-fitters who had not had the slightest experience of electrical work, and without our even having a magnet wherewith to test things as we went on. This work was done at Doncaster, and when the engine came up to London the signals were duly taken at fast speed.

"C. M. J." next tries to frighten us with the number of signals to be taken by a train travelling at 60 miles an hour over a line with four block stations to the mile. Well, the idea, certainly, is alarming; though why it will be harder to take in 30 signal indications in a minute given exactly where you expect them on the engine than looked out for on the roadside is not explained. Will "C. M. J." kindly say where, with four stations to the mile, trains are to be seen travelling at 60 miles an hour? The show would draw good gate money.

That, "with the road blocked ahead, the driver, when inside the distant, but before reaching the warning magnets, would have his "*home* "semaphore showing off, and," not "inviting him to run on," but giving him permission to move on, is true; it is also true that the distant signal would be *on* and telling him to slow down.

Next, as to failure of road numbers. It is no more possible to give the wrong number than to pull down the wrong roadside semaphore, the switches being interlocked

with the point levers; failure to give a road number would, *ipso facto*, show that something was wrong. If the signalman tries to run the express up to a bay platform, the driver will be made aware of the fact while a thousand yards away.

For single lines worked by signals it would probably be best to use only electro-magnets on the road. The danger magnets on each side of the line, however, might be connected in separate circuits with separate batteries.

Finally, I think it is better to try and avert danger than to maintain a nursery for the cultivation of "the sense of alertness to danger." By-the-bye, is this the sense which enables a driver to "assume" that he is passing an invisible signal at danger?

If "C. M. J." will be good enough to communicate with me I shall have much pleasure in showing him some apparatus connected up with batteries, so that he may see how really simple and compact the whole thing is.

W. S. Boult.

32, Victoria Street, S.W.
November 16*th*, 1899.

Contact Electricity.

May I make a few comments on the remarks you made in your generous editorial on the paper on "Contact Electricity," which I read before the Physical Society, and which was reported in your last issue?

You stated that I was dealing with differences as small as $\frac{1}{10}$th of a volt, and that in my experiments there were many conditions that might account for a stray $\frac{1}{50}$th of a volt. Very true; but as I entirely ignored such small differences in drawing conclusions from my results, the criticism is irrelevant. The changes to which I attached importance were from 1·02 volts to 0·28 volt, from 0·98 volt to 0 09 volt, from 0·37 volt to −0·60 volt, and so on.

You referred to errors caused by the electrification of the glass tube. Such disturbances are easily recognised, and, it is needless to add, were carefully eliminated.

Thermal differences, of course, did not come in to any appreciable extent, as all measurements were made when the apparatus was quite cold.

Frederick S. Spiers.

Consulting Engineers and Contractors.

It was not our intention to enter further into the discussion of the question of "Consulting Engineers and Contractors." Having put our question and obtained our answer, we were quite content to leave the matter in other, and more interested, hands; but your correspondent, Mr. Sydney F. Walker, raises an entirely new issue. The sort of consulting engineer which we thought the contractor had a genuine complaint against was the man who, posing as a consulting engineer pure and simple, was, at the same time, quite willing to act as a contractor if he could get a supply house to give him trade terms. The gentleman Mr. Walker has in his mind is, on the contrary, one who states boldly, "I am a contractor, but my experience is such that I am as capable (often more so) as any man to give my customers advice." He does not interfere with anybody, because he does not usually advise outside his own connection. This man, we have no hesitation in saying, is fully entitled to receive trade terms. True, his customers occasionally treat him in the mean manner Mr. Walker draws attention to. They get all they can out of him free, and then use their stolen knowledge to hawk their installation round the whole trade in search of someone who, not having spent time and trouble in preparing a workable scheme, is quite able to undersell him by a small percentage. But as a rule we do not think that this is so, and more often the work is placed in his hands without further question. There is, however, a worse form of enemy to the straightforward contractor, viz.:—the man who, being actually a contractor himself, poses as a consulting engineer, draws up a cast-iron specification insisting on dynamo "A," engine "B," wire "C," and lamps "D," on which he has special terms, being employed, and then tenders for the work himself, and, of course, is able to underbid everybody. Such a man is beneath contempt, we know, but, at the same time, is far too common, and should be discouraged, not to say gibbeted, wherever possible. However, this is entirely a matter for the trade, and in their hands we are content to leave it now we have set the ball rolling. One word only we should like to add. Owing to your anonymous correspondent, of the 10th current, not appearing in the "Correspondence" page, we had overlooked his contribution to the discussion, but now note that he refers to us as "a firm of contractors." This is just what we say we are not. We are a supply house wholly, and it was in the interest of the contractor that we first entered the field, and drew attention to the grievance which we thought our customer (the contractor) had.

For the Stewart Electrical Syndicate, Limited.
Douglas C. Bath, *Managing Director.*

November 21*st*, 1899.

I think the question raised by Messrs. The Stewart Electrical Syndicate is one which seriously affects the electrical trade.

In addition to the type of consulting engineer brought to notice in their letter, contractors have to face another form of competition by the consulting engineer who acts as buyer to the client, and personally orders plant and materials at trade prices, which are passed on to the client, who, although a private individual, thus obtains plant and materials at prices only intended for the trade.

The consulting engineer will further engage men, and send them on to the work where they are paid by the client at the men's ordinary rates.

This is obviously unfair to electrical engineers and contractors, whose business requires the maintenance of plant and staff, and it is regrettable that some supply houses and manufacturers of electrical plant are willing to give trade terms to the public through the consulting engineers. As a contractor, I avoid as far as possible doing business with those firms who I find have not the same consideration for their customers as is shown by the Stewart Electrical Syndicate.

Herbert E. Hall, A.M.I.E.E.

Tonbridge, *November* 17*th*, 1899.

Single-phase Motors.

With reference to Mr. C. E. L. Brown's letter on the above subject, appearing in your last issue, it would, I am sure, greatly interest all electrical engineers to know where single-phase motors, made by his firm, starting against full load, can be seen *at work*. It is not too much to say that the opinion of the electrical profession is, undoubtedly, that the design of the Brown motors does not lend itself to starting against any load greater than that offered by the usual loose-pulley arrangement invariably installed with them, *vide* the Brown motors running in London, Worcester, Frankfurt, Zurich, &c.

When Mr. Brown has given this information, it will be time to see if he can give guarantees to be compared with those given by Mr. Heyland.

A. C. Eborall.

Repeater for Wireless Telegraphy.

In reference to your article in last week's Review on Signor Guarini-Foresio's repeater for use in wireless telegraphy, we should like to point out that we already have secured patents for a precisely similar arrangement, including two other methods for getting over the disturbances due to "back surgings" when automatic relay stations are used; and which would, if no precautionary steps were taken, continue, until the battery power was exhausted. We have every confidence in its practical value, and when worked in conjunction with our multiplex selective system, it forms a complete method of inter-communication between towns or stations in a large country. For instance, in Great Britain a trunk line could be worked with repeating stations (at, say, 15 miles apart), from London to Edinburgh, and at different centres our automatic selective switches could be

introduced, so that any station *en route* could communicate with any other.

As our patents are still in the provisional stage, we regret that we are unable to publish further details.

Philip H. Cole.
Bertram S. Cohen.

The Dublin Cable Contract.

With reference to the letter of the British Insulated Wire Company, Limited, appearing in the issue of your journal of the 17th inst., our clients, the National Conduit and Cable Company, instruct us to state that the facts alleged therein are inaccurate, and the conclusions drawn are misleading; and we have already, upon their instructions, commenced an action for libel against the British Insulated Wire Company, Limited.

We are to ask you to be good enough to insert this letter in your next issue, together with a statement that your journal must in no sense be taken to concur in the imputations or purport of the British Insulated Wire Company's letter.

Renshaw, Kekewich & Smith.

Suffolk Lane, E.C.,
November 20th.

[It is generally understood that the editors of a journal are not responsible for the opinions expressed by their correspondents, and so far as the ELECTRICAL REVIEW is concerned this has been known to our readers for many years past. Naturally this would be so, as it is quite impossible for us to verify all statements that are made in letters published in our pages.—EDS. ELEC. REV.]

Electric Cranes.

We see in your article on the above subject that you give some figures as to power taken for certain work which are interesting, looking to the efficiency shown. We think, however, that referring to the crane shown on fig. 3A, there must be some mistake, as you say it only takes 21 amperes at 203 volts to lift the full load, 25 cwt., at the rate of 80 feet per minute. This must be wrong, and we suppose the speed has really been very much less, and that when lifting and slewing at the same time the speed of lift has been still further reduced.

Rosling & Appleby.

[The load in this case was a full skep of coal, weighing about 18 cwt.—EDS. ELEC. REV.]

ELECTRIC LIGHTING IN SHOREDITCH.

THE "PROFIT" QUESTION SETTLED.

THE Vestry on Tuesday devoted two hours and a half to a discussion of the proposals of the Electric Lighting Committee in regard to the allocation of the profits (£6,463) on the electricity undertaking during the past year. The recommendations of the Committee may be recalled as follows:—

(1) That the sum of £1,255 8s. 2d. be paid by the electric lighting revenue account out of the electricity surplus to the credit of the general rates, which sum represents all moneys heretofore advanced from that rate to the electric lighting undertaking; (2) that the sum of £2,931 12s. 2d. be paid by the electric lighting revenue account out of the electricity surplus to the dust destructor revenue account, and that the deficiency, amounting to £694 10s. 4d., on the dust destructor revenue account be written off as the value of steam supplied to the baths and wash-houses: (3) that an order on the treasurer be signed for £250, to be paid by the electric lighting revenue account out of the electricity surplus to the credit of the public libraries revenue account independently of their income from rates; (4) that the sum of £1,000 be transferred from the electric lighting revenue account to a reserve fund, to be called the "Electric Lighting Undertaking Reserve Fund," and that the amount be placed on deposit at the Vestry's bankers on the best terms as regards interest obtainable; (5) that the balance of £1,036 10s. 4d. be carried forward to next year's accounts.

Mr. H. WINKLER, as an amendment to No. 1, proposed that all profits made by the electric lighting undertaking up to March 25th last, should be appropriated to liquidate the losses and deficiencies incurred by the dust destructor.

Mr. ELSDON seconded the amendment.

Mr. S. G. PORTER contended that the statements made by Mr. Winkler were only good if they were correct, but the speaker expressed the opinion that they were inaccurate. The dust destructor, far from being a loss, could be turned into a remunerative concern if the Vestry were prepared to place upon its produce the full market value and for the steam supplied to the electric light station, and baths and wash-houses.

Mr. J. HEPBURN said a business man, on striking a balance-sheet, would have a profit represented by debts owing, cash in hand, and stock. Last year there was said to be a profit of £3,000, and this year one of £6,000, and he expected the latter would vanish as the former had done.

Mr. A. C. HODDER was not prepared to deny that the £6,000 had been realised by way of profit, but he thought Mr. Porter had given the show away when he stated that the destructor had not been credited with the due amount for power supplied. The profit had been earned by the destructor, and it was impossible to separate the two accounts.

Mr. H. E. KERSHAW said that the report of the Committee was practically unanimous. It was the desire of the Committee to pay into the general rate account—the losses made by the undertaking in the three years. With regard to the statement of Mr. Hepburn, he considered that that gentleman had answered himself. There was £800 in the bank, there was the stock in hand, and debts owing. They would be eternally discussing the question so long as members doubted the accuracy of the facts of the accounts.

Mr. J. J. FREEMAN did not think the members could be blamed for not accepting statements presented as facts to the Vestry. If the Committee desired the profits to be devoted to the general rates, why should there be so much palaver. He believed there had been a profit on the electric lighting undertaking, but a loss on the destructor which, however, he wished to see run on a financial basis. If they carried the amendment, they would be able to start with a clean sheet.

Mr. J. VANDY said that Mr. Freeman was anxious that the destructor should be a paying concern, but the Scavenging Department sought to attain that object by disposing of the refuse at 1s. per ton less than by barging it away. The undertaking was a success, and he believed that next year a profit of £12,000 would be realised. Every department should be charged its proportion of the expenditure.

Mr. E. T. ADAMS, in reply to Mr. WINKLER, stated that the figures he had quoted were quite correct. The figures were that a loss of £8,000 had been made on the dust destructor, and a profit of £6,000 on the electric lighting department.

Mr. G. W. HOWLETT was in favour of the Committee's first recommendation in regard to the payment to the general rate account. He failed, however, to see that there had been a loss of £8,000, and it seemed to him that the amount proposed to be credited to the destructor for steam ought to have been so credited before the accounts were made up.

Major WENBORN remarked that, after Mr. Winkler's statement had been corroborated by a responsible officer, he did not see why it should be ridiculed. If he had two shops, he would have put the loss on the one against the profits on the other, and that should have been done in the present case.

Mr. N. Moss stated, in the course of his reply to the discussion, that the accounts of the two undertakings would, in future, be combined as the Vestry had ordered.

The amendment having been rejected by a large majority, Mr. TROWBRIDGE, as a further amendment, proposed that the sum of £5,463 out of the available surplus of £6,463 should be paid from the electric lighting revenue to the credit of the general rate.

Mr. W. SMITHER seconded the amendment, which on a division was rejected by 25 to 23 votes. The first recommendation of the Committee was then agreed to, and, after some further discussion, the other proposals made by the Committee were adopted.

LEGAL.

STEGMANN *v.* O'CONNOR.

IN the Appeal Court on Thursday, November 16th, before Lord Justices A. L. Smith, Henn Collins, and Vaughan Williams, the case of Stegmann *v.* O'Connor came on for hearing. This was the appeal of the plaintiff, an electrical engineer, for a judgment of a Divisional Court, composed of Mr. Justices Bruce and Ridley, on February 18th this year, confirming the decision of the Official Referee. Counsel for the appellant (the plaintiff in the action) was Mr. Tindal Atkinson, and Mr. Clavell Salter represented the respondent (the defendant in the action).

In opening the case,

Mr. TINDAL ATKINSON said that he merely proposed to ask for the judgment of the Court on a single point, and it was really a question of the construction of a contract. That was a question of law. The point at issue was whether or not the plaintiff was entitled to £50, which the Official Referee had awarded him on his counterclaim, as being a penalty of the liquidated damages provided for by the contract. He (Mr. Atkinson) urged that the Official Referee had no right whatever to give that £50. Plaintiff (the appellant) was an electrical engineer, and the defendant owned a house at Nightingale Lane, Clapham, known as "Mont Cashel." On April 16th, 1898, plaintiff entered into a contract with the defendant, which was contained in two letters that passed between the parties, and there were specifications for an installation of the electric light at plaintiff's residence. Defendant was also to supply and put up the fittings for a sum of £76 10s., the work to be done to the satisfaction of defendant's architect, and the contract provided that plaintiff should pay £5 a day by way of liquidated damages for every day exceeding 20 days, within which time the work was to be completed. Defendant, when the job was concluded, declared that it constituted a breach of contract, and that it would have to be all done over again. In so doing, defendant used certain material belonging to the plaintiff which had been left in the house, and he counterclaimed for £150 as penalties. The Official Referee found

that the plaintiff had not executed the work according to contract and specification, and the defendant had occasion to call in another electrician to complete the work. He also found that the material used by the defendant, and which belonged to the plaintiff, was of the value of £2 16s., and allowed the plaintiff £9 3s. for extra work, or in all, £11 19s. Then, by way of liquidated damages under the contract, the Official Referee awarded the defendant £50, and deducting the £11 19s. for which he had found in plaintiff's favour, the Official Referee gave his certificate in favour of defendant for the balance of £38 1s. Mr. Tindal Atkinson said it was never suggested, nor was there any evidence to support such a finding, that the defendant had sustained any damage at all by reason of the delay or alleged breach of contract. The electric lighting installation was put up by the plaintiff within the specified contract time; it was found to be perfectly satisfactory, and was handed over to defendant in that state. Defendant had set forth a two-fold complaint. First, he said it was a term or contract that plaintiff should put in Silvertown wire—a well-known wire manufactured at Silvertown. It was true that plaintiff did not use that wire, although he had contracted to do so, for the reason that at the time he had not any such wire in his possession, and it being the Easter holiday time, when the Silvertown manufactory was closed, he (plaintiff) was unable to procure it. In those circumstances, and having only a short time in which to complete his contract, plaintiff put in another kind of wire, but one equally as good as Silvertown. Secondly, defendant complained that the plaintiff had put the wire in the lead tubing tight instead of loose. For these reasons the defendant had said that plaintiff was bound to do the work all over again.

Lord Justice Vaughan Williams said he noticed that the plaintiff only sued for £56, whereas the contract was for £76 10s.

Counsel, in answer to his Lordship, said that the contract was to put up the wires and fittings, the latter to be supplied by the defendant; but as the defendant never supplied any, plaintiff did not put them up, and therefore he only sued for the price of putting up the wires; in other words, for the installation only.

Lord Justice Vaughan Williams said the Official Referee had found that plaintiff was not entitled to anything for that.

Mr. Tindal Atkinson: Yes, he found that.

Lord Justice Vaughan Williams: And nothing for the fittings, because you did not put them up, and therefore on the original contract you were entitled to nothing.

Mr. Tindal Atkinson admitted that that was so, but he withdrew that part of the case now. However, he ought to mention that when the plaintiff went to defendant's house for the purpose of substituting Silvertown wire for that which had been put in, he was refused access to the premises, and was not allowed to do the work he was entitled to do.

Lord Justice Vaughan Williams: The only question is now whether the Official Referee was justified in giving the £50 damages against you. I suppose they were damages for not having carried out your contract?

Mr. Tindal Atkinson: Plaintiff was not allowed to complete his contract in its entirety, as he was not allowed to go on the premises for the purpose of finishing the work and receiving the promised fittings from the defendant. Counsel urged that defendant could not claim the £50 awarded to him under his counterclaim, when he himself had put an end to the contract. Mr. Tindal Atkinson submitted to the Court that the £5 a day provided by the contract was clearly a penalty and not liquidated damages. According to that construction of the contract the learned counsel asked the Court to say that the penalty could not begin to run until the whole of the contract had been completed, and that defendant could not claim any penalty when he had himself put an end to the contract.

Mr. Salter, for the respondent, asked that the finding of the Official Referee and the Divisional Court should not be disturbed. It had been shown in evidence that plaintiff's work was wholly bad and useless.

At the close of the arguments, their Lordships reserved judgment.

Chick & Co. *v.* Groth.

In the High Court of Justice on 16th inst., Mr. Justice Grantham, sitting in the Queen's Bench Division for the hearing of non-jury actions, had before him the case of Messrs. Chick & Co., City, exchange dealers and foreign brokers, who sought to recover from the defendant, Dr. Lorenz Albert Groth, consulting engineer, the sum of £773, being money lent, money paid at defendant's request, and for interest on advances. Mr. McMillan appeared for the plaintiffs, and Mr. Drake for the defence.

It appeared that the defendant, who had studied at Strasburg, Germany, and now carries on his profession in London, had invented certain processes for tanning by means of electricity, and he was introduced to Mr. Alfred Young Chick, one of the plaintiff firm, with a view to obtaining an advance of money from them. Plaintiffs' case was, that after going into the matter of the patents with him, they lent him money wherewith to complete his inventions here and abroad. Defendant pleaded that it was part of his contract that the loans were only to be repaid from funds to be obtained by the flotation of a company to work his patents; but on the other hand, plaintiffs alleged that the arrangement was that in the event of a company being formed, they were to receive a bonus, but that the amount of their advances was to be paid back to them, whether or not a company was successfully floated. Defendant was introduced to them in 1892, and the advances went on down to 1898, some of the money being payments for the purpose of keeping the patents alive. The patents were assigned to plaintiffs by way of security for their advances. Defendant pleaded that plaintiffs were the real promoters of the company, and that the fact of its not having been brought out was due to their fault. The validity of the patent had been established in the Chancery action, and there had been a successful flotation of a company in Sweden to work defendant's patents there.

His Lordship gave judgment for plaintiffs with costs.

BUSINESS NOTICES, &c.

Universal Electrical Directory (1900).—We are asked to announce that in order to publish the new issue reasonably early, the latest date for receiving new matter for advertisements and entries in the classified trades section has been fixed for Monday, December 4th. Those who have not already notified their requirements are asked to note this date.

American Machinery for Shropshire Mines.—We read in the *Iron and Coal Trades Review* that Mr. Duncan Sinclair, general manager of the Coalbrookdale Company, Limited, of Shropshire, is in the United States making some purchases of electric machinery for his company.

Bankruptcy Proceedings.—The first meeting of creditors was held on 17th inst. at the London Bankruptcy Court under the failure of E. A. M. Winter, Amberley House, Norfolk Street, Strand, electrical engineer. The debtor has filed accounts showing total liabilities of £1,550, of which £975 is unsecured and assets *nil*. He states that he is a German subject and came to this country in 1889. For some years he was in employment, but in May, 1897, having a capital of £700 or £800, he started business as the Imperial Electric Light and Power Company, his idea being to obtain concessions from public bodies and others for the supply of electricity, and to eventually form the business into a limited company. He travelled all over England, Scotland and Ireland, and entered into various contracts, but the business resulted in a loss to which he attributes the failure. In the absence of any offer, the case was left in the hands of the Official Receiver to be wound up in bankruptcy.

A sitting of the London Bankruptcy Court was held last week before Mr. Registrar Hope, for the public examination of E. C. Glass, lately carrying on business as an electrical engineer, &c., at 6 and 7, Nevill's Court, Fetter Lane, E.C. The debtor purchased the business for £2,000 in October, 1896, and subsequently introduced therein a further £1,000. He carried it on until November, 1898, when it was taken over by his sister in consideration of £3,000 previously advanced. During the next six months he remained in the business on her behalf, but then went abroad. He attributes his failure to heavy interest charged on borrowed money, and to his having lived beyond his means by reason of having over-estimated the profits of the business. The accounts filed under the proceedings show liabilities £1,098, and assets *nil*. The Official Receiver desiring further time for the purposes of investigation, His Honour adjourned the examination until December 7th.

Liquidations, Dissolutions, &c.—A general meeting of the Sheffield Electric Light and Power Company will be held on December 22nd at the office of T. G. Shuttleworth & Son, Royal Insurance Buildings, Church Street, Sheffield, to hear an account of the winding up from the liquidators, Messrs. G. Franklin and J. Gamble.

Messrs. C. H. Strong and W. H. Hartley (Electro-Medical and Surgical Institute, 18, Pall Mall East) have dissolved partnership.

Messrs. H. J. Dowsing and W. S. Hedley (trading as H. J. Dowsing, electrical engineers, Budge Row, E.C.) have dissolved partnership. Mr. Dowsing attends to debts.

Messrs. H. G. Massingham and F. H. Rippon (Massingham, Rippon and Co., electricians and electrical engineers, 82, Fore Street, Exeter) have dissolved partnership. Debts due to the firm will be payable to Mr. Rippon, 7 and 8, Queen Street, Exeter, and all accounts owing by the firm are to be sent to the firm at Fore Street as above.

Books Received.—"Le Phénomène de Zeeman," par A. Cotton. Paris: Georges Carré et Cie, Naud. 2 francs

No. 41. "The Safety of Theatre Audiences and the Stage Personnel against Danger from Fire and Panic." By Wm. Paul Gerhard. London: The British Fire Prevention Committee. 1s.

Brill Cars.—Some idea of the business at present being done by the Brill Company, of Philadelphia, is obtained from a notice in a New York electrical journal. The company is now engaged in building a large number of double-deck trolley cars for the General Traction Company, of Paris, which will operate street tramways from the centre of the city to the Exposition grounds in 1900. Owing to the size and weight of the cars they will be mounted upon heavy double trucks. Over 40 per cent. of the output of the Brill plant is for export. In addition to the French contract the company has one for 150 trolley cars for Lisbon, Portugal. Within the past few months the firm has shipped cars and trucks not only to several European countries, but to China, South Africa and South America. Large contracts for cars for street railways in Mexico and South American countries have been received, and will be filled within two months. Other foreign orders for car trucks are being filled for cities and tramway companies in Italy, France and England. The Brill plant is building at present over 2,600 trucks on foreign orders.

Correction.—In our notice of Watts, Rumford & Co. last week, under "New Companies Registered," we stated the qualification of directors at £100. We are asked to state that this was an error, the correct figure being £500.

Charge of Stealing Electricity.—A. J. Harrison, trading as Harrison & Co., electrical engineers, in King Street, Hammersmith, was brought before Mr. Lane, Q.C., on a warrant, in default of appearing to a summons, charged with stealing electricity by forming a connection with the Vestry's main wires.—Mr. A. B. Watson appeared to prosecute on behalf of the Hammersmith Vestry. With respect to the charge the prisoner said it was the result of a mistake.—A remand was granted, and it was suggested that the prisoner should be liberated on his own recognisances to appear, but Sergeant West objected, as the accused had left Hammersmith.—The prisoner said at the present time he was employing 20 men in Hammersmith.—Mr. Lane, Q.C., decided to call upon the prisoner to find bail, stating that he would accept a surety of £50, or two each in £25.

Prisoner was again before the West London Court on Tuesday. Mr. A. B Watson (Hammersmith Vestry) said the prisoner rented two rooms in the house of Mrs. Thomas, who had an installation of the electric light in her front shop, and in consequence of a dispute an examination of the wires disclosed that the meter had been tampered with. Mr. Bell, the resident electrical engineer to the Vestry, produced a meter with the fuse and indicator, and explained the working of it. He said he went into the cellar and found the fuse box broken. Larger fuses of a different material had been inserted with extra wires, allowing four times the quantity of electricity to be drawn from the supply. The prisoner was again remanded.

Colliery Equipment.—With reference to our note under this heading last week, the secretary of the Sussmann Electric Miner's Lamp Company, Limited, writes to make a correction. He asks us to state that Messrs. Reid, Ferens & Co., Limited, have no contract with the company, though he believes that they do contract with the South Moor Company to *repair* lamps supplied by the Sussmann Company. The point that he desires to emphasise is that the Sussmann Company are the sole manufacturers of the lamp.

The Copper Market in November.—Messrs. H. R. Merton & Co.'s mid-monthly circular on the state of the copper market shows that stocks have been reduced by 1,278 tons since the commencement of the month, the total now standing at 25,526 tons. A slight upward movement in price has attended this fall in stocks, the price of G.M.B.'s on November 15th being £73, as against £72 17s 6d. on October 31st. The deliveries have been 8,671 tons, the shipments to America, 343 tons, and the supplies 7,736 tons. The supplies are nearly all below the average, those from Spain and Portugal amounting for the fortnight under notice to only 5 tons; and those from North America to only 621 tons. Doubtless, the returns for the second half of November will help to restore the missing balance from these two sources of supply.

Dynamo Brushes.—Mr. W. Patterson, of Newcastle-on-Tyne, sends us a copy of a report of tests made by Mr. W. W. H. Gee, chief lecturer in the electrical engineering department at the Manchester Municipal Technical School, of his self-lubricating dynamo brushes on a small dynamo. The commutator is stated to have been cooler, the surface attained a highly polished surface with very little wear, and the use of lubricants is dispensed with. The maker claims that with these brushes there is no tendency to spark or fuse, and that the friction is reduced to a minimum, thus adding longer life to the commutator and brushes, and after setting require little attention.

Electric Swing Bridges.—The second of the new electrical swing bridges at Northwich was swung across the River Weaver on 14th inst. for the first time, although it was not then permanently opened for traffic. £25,000 has been spent on the two bridges. Each bridge is opened and closed by electric motors controlled by operators on duty in boxes at the bridges.

Important Steel Contract.—We understand that Messrs. Edgar Allen & Co., of the Imperial Steel Works, Sheffield, have secured the War Office contract for the supply of all the crucible cast-steels, grades B and C, required for the ordnance factories at Woolwich, Enfield and Birmingham during the next three years. Mr. J. C. Ward, A.M.I.M.E., is the London agent of the firm.

Intended Dividend.—The *London Gazette* contains notice of intended dividend in *re* B. Wild and J. H. Clarke (Wild, Rothwell & Co.), general and electrical engineers, Southport. December 9th is the last day for receiving proofs at the offices of Nathan Yates, liquidator, 4 and 6, Wood Street, Bolton.

Map of South Africa.—He would be an exceedingly unpatriotic man who could in these days keep his attention away from South Africa for long at a time. Full as the busy man may be with a thousand and one occupations, he finds it compulsory to sandwich in with them a dozen times during the day "the latest" from the front. But war news without some index of the situation of the various points of interest loses very much of its value and significance. To meet this want various maps have been issued by newspaper and other publishers, but we think that the most convenient and interesting so far is that which has just come to hand from the Exchange Telegraph Company. It contains several coloured maps in one of Natal, Orange Free State, Cape Colony, &c., and gives a very useful table of distances showing how many miles away from London are the various coast towns of importance, and how far it is from Cape Town, Delagoa Bay, Durban, &c., across country to the principal places now waiting for relief, and those likely to be the scene of action later when the real work of the war commences. The figures are ready to hand without the trouble of calculating.

Provisional Orders.—The *London Gazette* contains the usual notices of application for electric lighting and tramway powers as follows:—*Electric Lighting.*—Totnes Electricity Supply Company (Arundel Street, Strand, W.C.); Hebburn Urban District Council; Penzance Council; Vestry of the Hamlet of Mile End Old Town; Barnstaple Corporation; St. George's in the East Vestry (London). *Tramways.*—Walthamstow Urban District Council; Aston Manor Urban District Council; Hurst Urban District Council; Barnsley Corporation; Newcastle-on-Tyne Corporation (to grant a lease of certain lines to the Newcastle and Gosforth Tramways and Carriage Company, Limited).

Sale Announcement.—When the undertaking of the Midland Acetylene (Patent) Syndicate, Limited, was offered for sale by auction at Birmingham last week, there was not a single bid. The works will therefore be dismantled and sold piecemeal at an early date by Mr. H. Humphries, auctioneer, of Brierley Hill and Stourbridge, from whom particulars may be obtained. The undertaking comprises the freehold works, with the whole of the electrical plant, Peach engines, three Danks's Lancashire boilers, &c.

Scotch Water-Power Scheme.—The Glasgow newspapers contain references to a scheme which is understood to be on foot, under which a syndicate proposes to consider the advisability of utilising the waters of Loch Doon for manufacturing purposes. The proposal is to raise the loch 20 feet, and construct a dam close to the famous Ness Glen, where the electricity would be generated. This glen is expected to yield 5,000 H.P. In the event of powers being obtained, it is not at all unlikely that the power would also be used for the proposed light railway from the village of Dalmellington to Carsphairn. For some time parties have been prospecting for hematite in the hills at the head of the loch, so a mineral railway may also be required. At the present time Loch Doon and the Ness Glen are annually resorted to by thousands of anglers and holiday makers.

The Society of Model Engineers' Conversazione.—The first annual conversazione of the Society of Model Engineers was held on November 11th, at the Memorial Hall, Farringdon Street, E.C. The guests were received by the chairman, Mr. Percival Marshall, A.I.Mech.E., and Mrs. Marshall. A splendid collection of engineering models and tools was on view, the exhibitors including Messrs. C. A. Parsons & Co., who sent a model of a 35-knot torpedo boat destroyer, and a model of a 30-knot cross-Channel steamer; the Great Eastern Railway Company, who sent a model of a single-driver express engine, and samples of Mr. Holden's oil fuel burner and other models; and the General Electric Company, who showed electrical apparatus for domestic uses. A lecture was given on "The Light Side of Science" by Mr. W. J. Tennant, A.I.Mech.E., and demonstrations of the X rays and of Edison's latest phonograph afforded additional entertainment for the guests. Mr. Herbert Sanderson, The Mount, Ealing, W., is secretary of the Society.

South Wales Electric Power Scheme.—It is stated in the South Wales papers that statutory notices have been filed for a private Bill by the South Wales Electrical Power Distribution Company. Briefly stated, the promoters' object is to establish three stations for the generation of electricity; one in the parish of Panteg, near Pontypool; another at Treforest, near Pontypridd; and a third at Neath; and from these to supply electric current both for trade and lighting purposes. It is intended, by arrangement with the railway companies, to lay the electricity cables alongside the railways, and thus to minimise the difficulty of transmission; and the desire of the promoters is to make the delivery in bulk, leaving consumers to undertake all the detail of application, whether for illumination, colliery haulage, dock work, or any other form of trade adaptation. As the company do not seek a monopoly, the antagonism of local authorities is not anticipated. It is considered that instead of undergoing the trouble and entailing the trouble and expense of a separate installation, many of the local Councils would prefer to become customers of the company. The districts affected are the Monmouthshire valleys, with the borough of Newport, the Glamorgan valleys, with Merthyr, Aberdare, &c., the borough of Cardiff, Port Talbot, Swansea, Barry, Neath, and the numerous intervening parts of the populous region indicated. All these places being connected by electric mains laid along the railways, any manufacturer or resident will be able to get a supply of electricity by meter; and the local Councils, the proprietors of light railways, the owners of collieries, tinplate works, dry docks, brickyards, &c., will get in cheapest form an abundant service of power and light. The extensive ramifications of the railway systems in this part of South Wales afford easy and plentiful access to every part of the district to be served. It is estimated that the cost of electric power will be very low. Hydraulic power has been worked out as having a minimum cost of £26 per horse-power per annum for 300 days of 10 hours each; and gas engine power at £22 10s.; whereas the South Wales Company expect to be able to make their supply of electricity for a charge which would amount to not more than £15; the great facility being the wholesale production and consequent relative cheapness. Where street disturbance became necessary the company would leave the local authority to do the work at the company's cost. The engineers for the scheme are Sir Frederick Bramwell and Mr. Graham Harris, and the Bill is promoted by many of the most influential commercial men and colliery owners in South Wales. At first not more than half a million sterling would be required as subscribed capital.

The Steele Earthing Device.—This device, which is being manufactured by Messrs. Veritys, Limited, has been submitted to the Board of Trade for their approval. After a long series of tests we are informed that these instruments have been shown to yield very reliable results, under crucial conditions, to the satisfaction of the Board

of Trade authorities as stated in their following letter dated July 21st:—

With reference to your letter of the 12th inst., on the subject of the Steele Earthing Device, I am directed by the Board of Trade to state that this form of earthing device was recommended to them for approval, but as a modification has been made in the regulation, under which the Board of Trade approval to an earthing device of this nature was required, the Board regret that a formal approval cannot now be given.

(Signed) T. H. PELHAM.

The Board of Trade Fisheries and Harbour Department,
7, Whitehall Gardens, London, S.W.

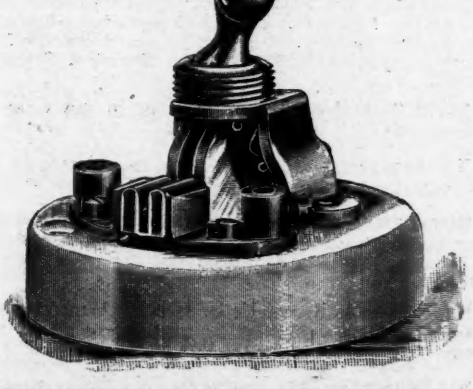
Temporary Scaffolds.—Mr. Heathman has produced folding brackets to hook on the rungs of any ladder and sustain scaffold boards as well as to act as a guard protection rail. The illustration shows how the brackets can be used either in front of or behind ladders and adjusted at various angles to suit the rake of the ladders. The brackets are of wrought-iron wide enough to hold two boards, side by side, and any piece of quartering can be passed through the sockets and jambed by the fixed thumb screws so as to guard the worker against inadvertently stepping backward. The brackets are made by Heathman & Co., of Endell Street, London, W.C.

Trade Announcements.—Mons. A. Molteni is announcing to the trade that after having been for more than 40 years at the head of the firm founded at Paris in 1782 by his great-grandfather, he has given up the business to Messrs. Radiguet & Massiot. All orders should be addressed either to 44, Rue du Château d'Eau, or to 15, Boulevard des Filles du Calvaire, Paris. Accompanying this notice is another stating that Mons. Radiguet has taken into partnership M. Massiot, his collaborateur. They have amalgamated their works for the construction of mechanical instruments, and X ray apparatus, with M. Molteni's works for constructing apparatus for projections. The new works have been considerably enlarged and fitted up with up-to-date machinery. The style under which the new business will be known is MM. Radiguet & Massiot.

We are asked to state that the showroom and depôt of the Edison and Swan Company, at 53, Parliament Street, S.W., have recently undergone alterations, and been completely renovated, and inspection of the fine collection of latest designs in electrical fittings is respectfully invited.

The Renewable Electric Lamp Company, Limited, have occupied the premises 47, Brunswick Place, City Road, E.C.

Undertype Switches.—The Imperial Electrical Engineering and Stamping Company, 63, Lionel Street, Birmingham, send us samples of switches which they are putting on the market. Both are well designed, and made to fulfil ordinary requirements.



The undertype switch, which we illustrate, has a long break obtained by countersinking the porcelain to admit of the plunger being withdrawn below the jaws of the contacts, and the distance from metal to metal is ample throughout for the carrying capacity of the switch. The ordinary tumbler type is much superior to any we have seen.

Totnes.—The Totnes Electricity Supply Company, Limited, has given notice of intention to apply to the Board of Trade to obtain a provisional order for the supply of electricity for public and private lighting in the borough.

ELECTRIC LIGHTING NOTES.

Abertillery.—The District Council has appointed Mr. L. A. B. Atkinson, electrical engineer, Cardiff, at a fee of 20 guineas, to report upon the lighting of the South Ward of the district by electricity.

Barmouth.—The report of Mr. Warden-Stevens on an electric lighting scheme was before the District Council last week. He details both steam and water-power plants. The cost of a water-power scheme is given at £9,500. A light electric railway is suggested for running along the sands, costing £6,500. It was decided by the Council not to take any steps until the public had been consulted, and a public meeting was arranged for.

Bermondsey.—The Vestry on Monday resolved that Messrs. Kincaid, Waller & Manville should be instructed to prepare a specification for the erection of a refuse destructor in connection with the electric lighting station.

Bolton.—Considerable friction has recently been occasioned between the Gas and Electricity Committees with reference to the question of street lighting, both contending for the privilege of doing the work. When the matter was last before the General Purposes Committee, the proposal to leave the street lighting in the hands of the Gas Committee was adopted, but at last week's Council meeting it was contended by Mr. Smith that it was only fair that the Electricity Committee should be represented on the Lighting Committee. Mr. Alderman Miles, chairman of the Gas Committee, said until it could be shown that the Electricity Committee could light the borough better and cheaper than the Gas Committee, he should most strenuously oppose the work being taken away from the Gas Committee. The chairman of the Electricity Committee, Dr. Panton, accused Alderman Miles of having made erroneous statements as to what had taken place in reference to the lighting question. The Electricity Committee hoped to be able to show what they could do in the way of arc lighting, and he believed they could do it efficiently and at no great cost. The proceedings were adopted,

Bootle.—A Local Government Board inquiry was held last week *re* the Council's proposal to borrow £15,393 for additional mains and feeders, and £1,000 for a new boiler for the electricity works.

Bristol.—The Electrical Committee have considered the position of the negotiations with the promoter of the proposed local Free Wiring Company, and resolved to confirm their previous resolution to terminate the negotiations.

Burnley.—The municipal electric lighting plant was started in 1893. It then consisted of two 180-H.P. compound condensing engines, capable of supplying electrical energy to some 6,000 8 C.P. lamps. The lamp connection, however, so much increased above the plant capacity that the Electric Lighting Committee decided to make a very substantial increase in the plant by putting down extensions capable of dealing with some 16,000 8-C.P. lamps. The completion of these extensions was celebrated on Monday, when the Mayoress (Mrs. Dickinson) performed the ceremony of starting new engines, &c.

Bury.—The Local Government Board has notified that it will hold a local inquiry regarding the Council's proposal to borrow £800 for lighting the road on the Brown estate by electricity.

Buxton.—The Electric Lighting Committee has suggested the appointment of an electrical engineer at £200 per annum. It is stated that the works will not be ready in January.

Camberwell.—The Vestry will hold a statutory meeting on December 18th to consider the question of the purchase, &c., of the County of London and Brush Provincial Electric Lighting Company's undertaking in Camberwell, or to apply for a provisional order to enable the Vestry to supply the parish.

Cardiff.—The Board of Guardians have deferred the question of lighting the workhouse by electricity for the present.

Cheadle.—The Cheadle Urban Council has adopted a resolution to the effect that application be made to the Board of Trade for a provisional order to authorise the Urban District Council of Cheadle and Gatley to supply electricity within their own district.

Cheltenham.—The Borough Council has given notice of its intention to apply to the Board of Trade for leave to alter the standard pressure from 100 to 200 volts.

Cleethorpes.—The Council is applying for an electric lighting order.

Clontarf.—The District Council is negotiating with the Tramway Company with a view to obtaining electric supply for lighting from the tramway generating station.

Colwyn Bay.—A Local Government Board inquiry was held last week *re* the Council's application for powers to borrow £5,120 for electric lighting. The previous loan was for £1,564. The contract has been let to Mr. B. Thomas at £3,678, and the applications to date are 1,105 lights, but the new pier company and other parties will take an equal number when the extensions are completed. Mr. Clirehugh, consulting engineer, detailed the scheme, which is for 10,000 8 C.P. lamps. The loan was opposed by the vicar, who was stated to be a gas director.

Coventry.—The quarterly statement of the electric lighting department of the Corporation to September 30th shows 36,007 units supplied, and a revenue of £764 with 159 consumers, as against 15,875 units, £411 revenue and 118 customers, for the corresponding quarter last year.

Cumberland.—The Egremont Urban District Council and the Maryport Urban District Council have both decided to apply to the Board of Trade for provisional orders for the supply of electricity in their respective districts.

Dawlish.—CORRECTION.—The public meeting which was called to consider the question of electric lighting decided, not in favour as stated last week, but against the proposition, which has, therefore, been dropped.

East London (S. Africa).—Particulars are given in the Cape newspapers of the new electrical installation at East London. The installation is for both lighting and tramway traction. The plant consists of three continuous-current dynamos of 75 KW., one to be used for arc lighting, and another for tramway work, the switchboard being so arranged that the third can be used for either lighting or traction as required. Two alternators, each capable of supplying 2,500 16-C.P. lamps, are used for private lighting and the street incandescent lamps. The current is supplied from the alternators at a pressure of 2,000 volts, and in the transformer houses is converted to 110 volts. All the engines are of the Belliss enclosed type, and there are three water-tube boilers of the Babcock & Wilcox type, fitted with superheaters. The installation has been carried out by Messrs. Reunert & Lenz.

Epsom.—The surveyor having declined the appointment of architect in connection with the electric light station, on the ground that his time is fully occupied by his ordinary duties, the Council has decided to ask Mr. Hawtayne to do the work or provide an architect at a fee of 5 per cent. on the contract, to include quantities.

Glasgow.—On Friday evening last the electricity supply to the north-western district of the city was interrupted for about 15 minutes, owing to the heating of the bearings of a 900 H.P. engine at the Port Dundas station. Another stoppage occurred at a later hour, due to the blowing of the battery fuses; the district was this time in darkness for about 20 minutes.

Gloucester.—We are informed that the National Electric Free Wiring Company, which has been at work here for three weeks only, has already secured contracts for electric lighting totalling up to 1,020 8-C.P. lamps. Amongst the orders are All Saints' Church, 112 lights; the Wellington Hotel, 120 lights; Messrs. Lloyds & Co.'s new bank, 270 lights. Current will not be available until next March, so that the prospects of supply here seem excellent.

Grantham.—The Urban Electric Supply Company, Limited, has given notice of an application to the Board of Trade for a provisional order for the supply of electricity for public and private purposes within the borough of Grantham.

Greenock.—The Police Board is going to hold an electrical exhibition of a week's duration.

Guisborough.—The Northern Electric Supply Company has applied to the Guisborough Urban District Council for consent to its obtaining powers for laying down electric plant in the Council's district. As the Board had not had time to consider the proposals its consent was withheld, but no opposition will be raised provided satisfactory terms can be obtained.

Harrogate.—Mr. F. H. Tulloch, on behalf of the Local Government Board, on Thursday, last week, conducted an inquiry into an application made by the Harrogate Corporation for sanction to a loan of £28,000 for the purchase and extending of the electric lighting installation. At the present time there are 22,341 lamps connected with the mains. The profits for this year up to date, after meeting interest and sinking fund and all charges, were over £700. The present mains are 10 per cent. overloaded during the heavy lighting season, and additional trunk mains are urgently required. There was no opposition.

Hastings.—The Local Government Board has sanctioned the borrowing of £38,334, being portion of the sum of £38,613 for which sanction was sought by the Town Council to meet the amount expended in excess of the loan of £58,000 sanctioned for the purchase of the undertaking of the electric light company, the excess being for additional machinery, mains, and buildings.

Hereford.—The electric light installation at Hereford is expected to be completed and ready for opening by December 13th. It is understood that the supply to commence will be equal to 3,000 8-C.P. lamps. The opening ceremony has been delayed in consequence of the machinery at the head station not being delivered to time.

Hornsey.—The District Council on Monday resolved to appoint an expert to advise them as to the question of an electric installation. The Council have the provisional order, and many offers have been made by private companies to take it over. The Council also decided to ask these companies for definite offers.

Hounslow.—The Heston-Isleworth District Council have decided to make an application to the Board of Trade for powers to light a portion of their district with electricity.

Hoylake.—The District Council is reported to have accepted tenders to the amount of £20,660 for electricity supply purposes.

Ingleton.—The work of laying the cables is now being rapidly proceeded with. The weir has been finished and the pipes and troughs conducting the water to the turbines almost completed. The directors hope to have the streets lighted by the middle of December.

Jarrow and Hebburn.—The Walker and Wallsend Union Gas Company is seeking powers to supply electricity within the borough of Jarrow and urban district of Hebburn.

Liverpool.—Last Friday Colonel C. H. Luard, R.E., Local Government Board inspector, held an inquiry into an application of the City Council for sanction to borrow £300,000 for purposes of electric lighting. The town clerk stated that in the year 1896 the Corporation purchased the undertaking of the Electric Supply Company, and £500,000 was authorised to be raised for the purpose of providing the purchase money and erecting works. That money had already been spent, as also a further sum of £100,000. The number of 16-C.P. lamps in existence when the purchase was completed was 41,515, now it stood in round numbers at 100,000. There had also been a reduction in the charges, which in 1896 were 7½d. per unit for lighting and 5d. for power, and were now for private lighting 4d., for public lighting 2d., for power 2d. and 1d. In spite of these substantial reductions a profit of over £8,000 was made in 1898 after providing for sinking fund and interest. The demand for electric light was increasing, and with the extensions now proposed it would no doubt be accentuated. An important factor was the acquisition by the Corporation of the tramways and the introduction of electrical haulage, which made increasing demands upon the electric supply stations. Excluding Pumpfields station, which was erected out of money recently borrowed, the stations were producing 10,000 B.H.P., and the stations to be erected would furnish a further horse-power of about 15,000, of which about 500 H.P. would be required for tramways. Really the Corporation would require £388,000 to carry out the proposed extensions. Although the £300,000 might seem a large sum, the Corporation at no distant date would have to ask for powers to borrow a further sum. The cost of buildings, land, and sidings for Pumpfields, Lister Drive, Smithdown Road, Lodge Lane, and Low-hill stations came to £102,000; the plant would cost £167,300, and the mains £119,400. The sites of the Pumpfields and Lister Drive stations belong to the Corporation, but the electric supply accounts would be charged a rental on the capital value. Mr. Holmes and Mr. Shelmerdine explained the plans and the details of the scheme to the inspector. The Tramways Committee is laying lines for electric trams at the rate of one mile per week. It has three or four lines of tramways almost ready, waiting for the electric power for which the money now asked is required. No opposition was offered to the application.

Llandudno.—The report of M. A. H. Preece on electric lighting plant extensions has been received by the Council.

London.—The tender of Mr. J. C. Christie for electric wiring of Paragon School, New Kent Road, offices, &c., has been accepted by the London School Board.

Lynn.—The resident engineer of the electric lighting works having reported that owing to the number of applications for current it has become necessary to extend the plant, the Town Council has resolved to purchase temporary plant at an estimated cost of £750 or £800.

The question of wiring the workhouse for electric lighting has been occupying the attention of the Board of Guardians.

Newhaven and Seaford.—An application is to be made to the Board of Trade by a company for provisional orders under the Electric Lighting Acts, 1882 and 1888, to supply electricity for public and private purposes within the urban districts of Newhaven and Seaford.

North Ormesby.—The Council is to apply for a provisional order.

Northampton.—There was a gas explosion in an electric light culvert last Saturday evening.

Oswaldtwistle.—The Lancashire Electric Power Company, having solicited the support of the District Council to a Bill in Parliament, the Council decided that the request be complied with.

Redcar.—The Redcar Urban District Council has resolved to apply for a provisional order for the supply of electricity in the district.

St. Pancras.—The Vestry on Wednesday resolved to forward to the Islington Vestry a copy of a letter received from the Board of Trade on the subject of the long-pending dispute between the two authorities as to the laying of mains in Brecknock Road and York Road, Islington, for the supply of consumers whose houses are situated in St. Pancras. The letter intimated that as the Vestry sought a license merely to lay mains, but not to supply current in Islington, and as Section 3 of the Electric Lighting Act, 1882, only empowers the Board to authorise *the supply of electricity* within any area, the Board could not entertain the application for a license. The Board further stated, as mentioned a year ago, that the question was one for friendly agreement between the two authorities. On the recommendation of the Electricity Committee, the Vestry also decided to ask Islington now to consent to St. Pancras laying the necessary mains.

(*Continued on page* 849.)

ELECTRIC CRANES.

(*Continued from page* 807.)

Where single motor overhead cranes are used they may take either of two forms; the winding drum may be retained at the end of the crane where the motor is fixed, and the load raised by means of a return block carried in a bight of the chain. One end of the chain is fixed at the end of the crane opposite to that which carries the motor, and the bight of the chain supporting the block is borne on a travelling jenny, which is pulled to and fro by means of chains. This construction was well shown in one of our illustrations last week; it is better suited for small loads than for large.

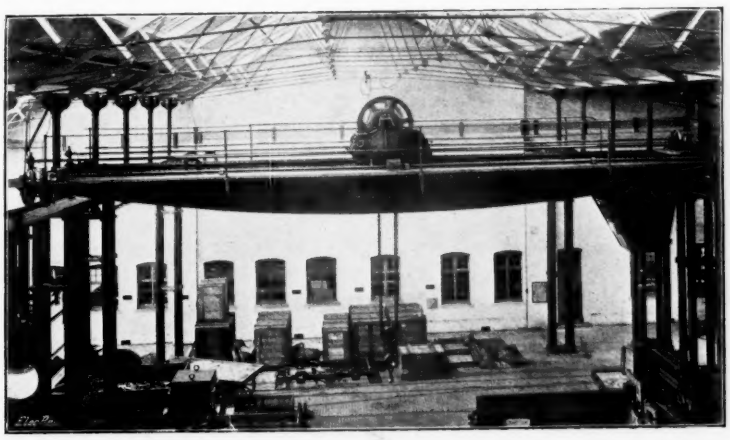


Fig. 12.

Another method is that in which the traversing and heaving gear is mounted on a crab running along the beams, and receiving power for these motions from square shafts or round shafts with sliding feather. Figs. 12 and 13 show the construction of a crane on the latter system, one of five supplied to the Electric Construction Company, Limited, for their works at Wolverhampton, by Messrs. Carrick & Ritchie. Fig. 14 is a view of a similar crane, showing the arrangement of the friction gear and electromotor.

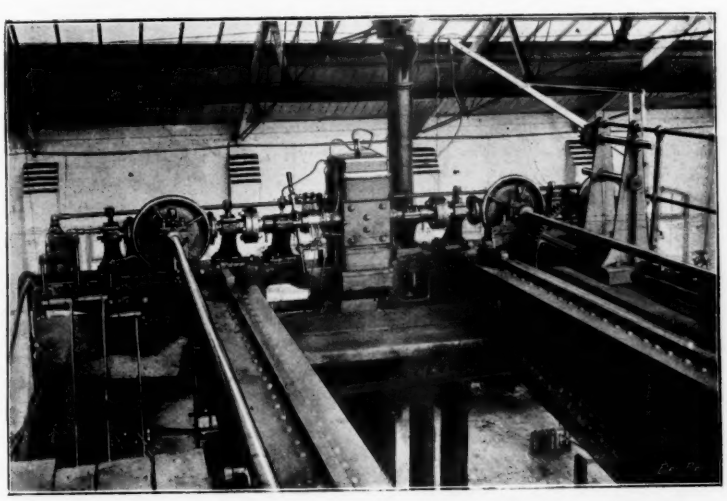


Fig. 13.

The crane illustrated is designed for a maximum load of 10 tons; cranes intended for larger loads are provided with three speeds of lift. The motor is shunt-wound, and is kept running, except when the crane is not likely to be wanted for some time. Reversing is provided for by means of the double friction cones, as explained in our last issue. All the motions may be utilised simultaneously, and are controlled by the driver from a cage beneath the crane.

Power is supplied to the traveller by means of a simple overhead wire and sliding shoe at each end of the crane, one of which is clearly seen in fig. 13.

It will be noticed that all the bearings are provided with removable covers, and that there is a platform on each side of the crane; the construction is as far as possible of steel.

The system of operating all the motions with a single motor obviously resembles closely that used on cranes supplied with power by mechanical means, the only fundamental change being the substitution of electrical apparatus for the continuously running shaft or rope; while, therefore, it affords a cheap and easy means of converting mechanical to electrical cranes, it does not fully utilise the advantages of electrical driving. Even so, the gain is undoubtedly great, for the power wasted in running a shunt motor on zero load for a great part of the day is certainly far less than that absorbed by a rope or other mechanical drive, which, moreover, is generally running the whole day long. Still, the use of three motors is clearly more economical in running cost, though the initial outlay may be somewhat greater; the motors may also be reversed electrically, so dispensing with mechanical reversing gear, which is not possible with a single motor outfit unless the motions are never used simultaneously.

In this connection the suitability of three-phase motors for crane driving deserves special notice. While they can be reversed most easily, without the possibility of sparking which is ever present in the use of direct-current motors, they can also be switched on at full load, when of moderate power, without starting resistances of any kind. Even when the motors are too large to dispense with resistances, these can easily be incorporated with the rotors in such a way as to be automatically cut out by means of a centrifugal device when full speed is attained. The controlling apparatus is therefore of the simplest, while the motors themselves are capable of running for long periods without the slightest attention.

Unfortunately, however, though this system has been largely adopted in Continental works, it is as yet almost

unknown in practice in this country; that its advantages will eventually be recognised here also, for transmission of power for all workshop purposes, cannot be doubted, though it is not likely ever to supersede direct current for lighting purposes.

Returning to our subject, we illustrate in fig. 15, one of a number of swing pillar cranes, made by Messrs. Carrick and Ritchie for Messrs. Thomas Parker, Limited, and fitted with Messrs. Parker's motors.

These cranes are used for discharging goods from barges on a canal and transferring them to a warehouse at the back. This is a single motor crane, fitted with friction gear, as seen in the figure; the motor is of the enclosed type, with radiating fins cast in the yoke.

As soon as the load is clear of the barge it is run in along the jib by means of the jenny and swung round for deposit in the warehouse, all three motions being in use simultaneously. The weight of the motor and gearing is applied to partly counterbalance the load. The simplicity of the crane, and the small space occupied by it, are noteworthy; the gearing, however, is necessarily somewhat complex.

Fig. 15.

A three-motor 30-ton crane, of 60 feet span, is shown in fig. 16. This is provided also with a quick lift for loads up to 5 tons. The travelling gear is driven from the middle of the span by a motor fixed at the end. This crane was constructed by Messrs. Cowans, Sheldon & Co., Limited, of Carlisle; another example of their work, of a type which we have not previously illustrated, is the walking crane shown in fig. 17. This is a cheap and handy type of crane for dealing with moderate loads, not requiring a high lift, and may easily be fitted up in buildings of too light construction to bear the weight of an overhead traveller. The crane illustrated is capable of lifting 5 tons, and is provided with two motors for lifting and travelling; both are of the Bushbury enclosed type, and the first speed reduction is effected by means of worm gear. The jib is swung by hand, friction rollers being used to facilitate the motion. Current is conveyed to the crane by overhead sliding shoes, as usual; the conductors are carried down the column to the hollow base, upon which the controlling switches are fixed, and current is supplied to the lifting motor by means of contact rings fixed on the upright column and brushes carried by the swinging frame.

The Goliath crane shown in fig. 18 is intended for use in timber or goods yards, spanning several lines of rails, or for erecting heavy machinery in the open. The clear height below the beams is 50 feet, span 50 feet, maximum load 20 tons. A separate motor with worm gear is used for each motion, current being conveyed to the motors on the crab by means of the six bare wires seen in the figure; the main supply is brought to the crane by overhead conductors supported on poles.

The travelling motion is effected by means of a single motor driving three shafts of a total length of about 150

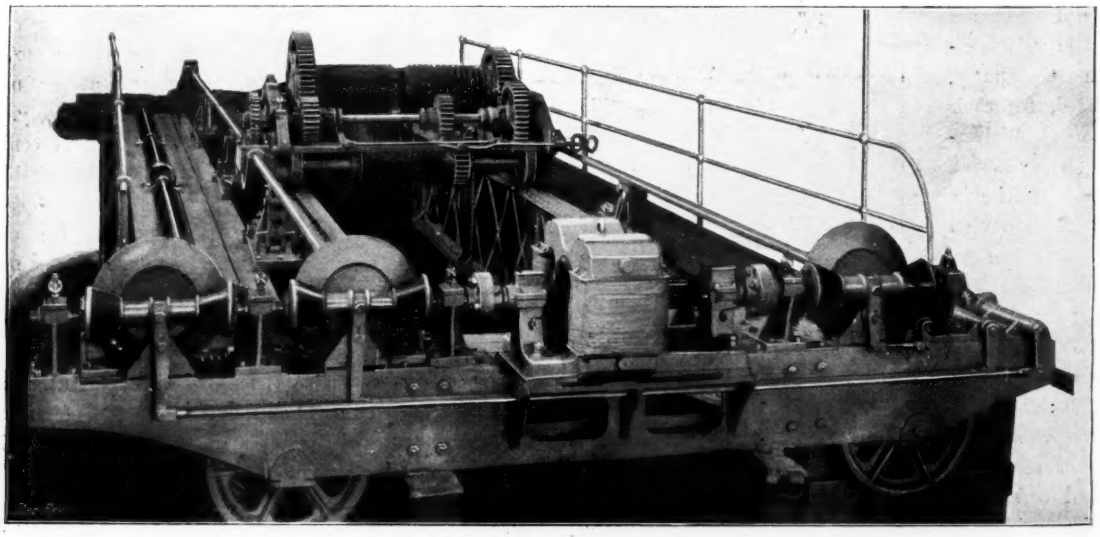


Fig. 14.

feet; to as far as possible avoid difficulties due to the spring of such great lengths, which would introduce injurious stresses on the framing, the motor, which is fixed at one end, drives the shafting by spur gear mounted at the middle of the span. All the motions are controlled by liquid resistance switch gear from a cabin mounted half-way up one side of the framing.

This is an instance in which no other means of transmitting power to the crane could be practically applied, the only alternative being the use of a self-contained steam plant, with its obvious drawbacks and excessive coal consumption.

(To be continued.)

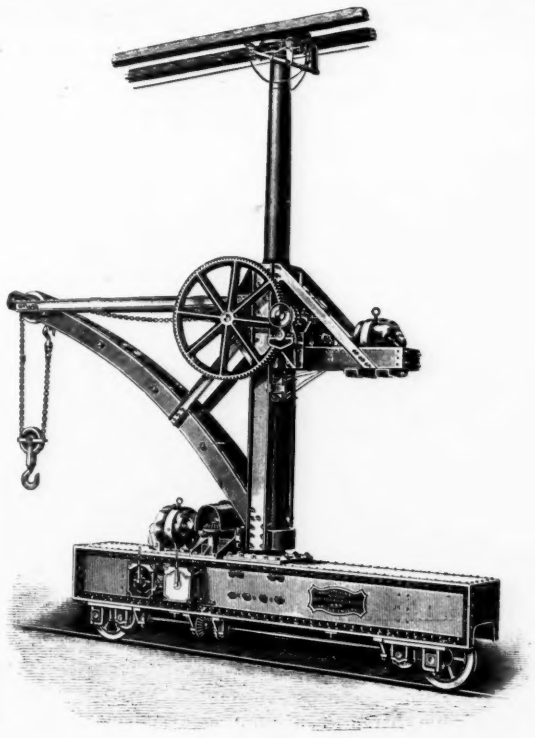


Fig. 17.

APPLICATIONS OF ELECTRICITY AT CRIPPLE CREEK, COLO.*

Few mining districts in the United States are so well adapted to the use of electric power as Cripple Creek. The small area of the district and the close proximity of the mines make the transmission of electricity an easy matter; while the fact that most of the mines are small in extent—whatever their output may be—makes the maintenance of separate steam plants costly, and the purchase of power from others an economy as well as a convenience. The pioneers in this district were quick to recognise the facilities for domestic and mining operations which electric transmission would afford. Probably no other mining district is so thoroughly supplied with electricity, for the home of the miner is lighted by incandescent lamps; he goes to his work in an electric street car; by an electric hoist he descends the mine; electric lamps furnish illumination for his work; electrically-driven pumps keep the mine dry; electric air compressors run drills; electric hoists raise the ore, and by electricity the blasts are fired from switchboards remote from the point of explosion.

* *Engineering and Mining Journal.*

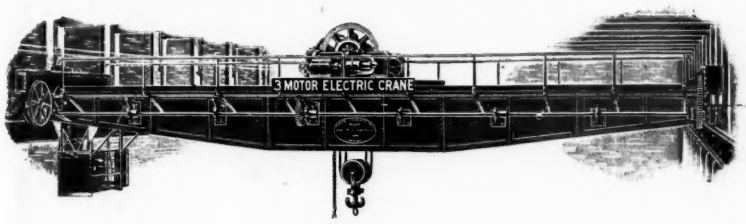


Fig. 16.

Fig. 18.

Electric current is supplied to the mines by the Colorado Electric Power Company, which operates three Westinghouse alternating current 470-kw. generators, three-phase, 500 volts, capable of supplying 2,250 h.p. This station transmits current 27 miles to Cripple Creek, at 20,000 volts. A plant has also recently been established by the La Bella Mill, Water and Power Company for supplying power to its mills and mines.

In many mines in the district Westinghouse type C induction motors have been introduced for hoisting, pumping, operating air compressors for drills, lighting, and for operating crushers and other machinery. The Colorado Ore Reduction Company has a 150-h.p. Westinghouse motor for operating its crushing machinery. Fig. 1 shows two Westinghouse type C motors operating crushers, the motors being partitioned off from the crushers to preserve them from the dust, and the belts passing through the partition to operate the machines. Fig. 2 shows a Westinghouse type C motor operating the mine hoist of the Wisconsin Mine, Cripple Creek. The Lily Gold Mining Company uses 100 h.p. for operating hoists and air compressor; the Moon Anchor Gold Mining Company has a 100-h.p. Westinghouse type C motor for pumping from a depth of 600 feet. The needs of the majority of consumers range from 75 h.p. down to 5 h.p. A Westinghouse type C motor of 15 h.p. suffices for hoisting through a shaft 450 feet deep; when this depth is exceeded a motor of 30 h.p. is used, which will be sufficient for a depth of 800 feet; for still greater depths motors of from 75 to 100 h.p. are installed.

The companies supplying electric power give every facility to lessees and prospectors; they rent small hoists, worked with electric motors, from 5 to 30 h.p., thereby enabling the lessee or prospector to use practically the whole of his capital in development work,

avoiding the necessity of purchasing and installing a power plant. If they are successful, and ore is found in paying quantities, making it desirable to purchase the electrical power plant, an option of purchase is exercised

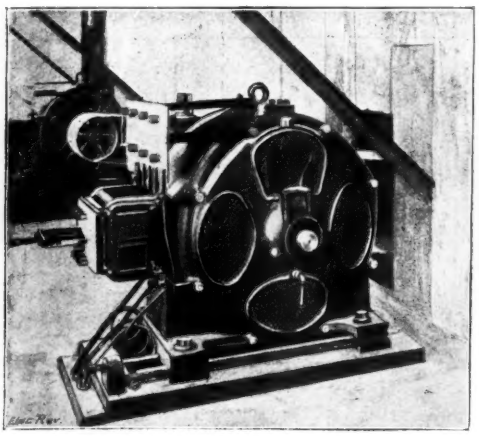


Fig. 1.—Motors Operating Crushers.

which the company granted in the first instance, the rent which has been paid applying on the purchase price. The minimum charge for a 5-H P. electric hoist is $50 per month, which includes the power used. The plants from 15 H P. to 30 H P. range from $65 to $200 per month for rent of motor, &c., and power supplied, depending on tonnage and depth of shaft. The Electric Power Company has

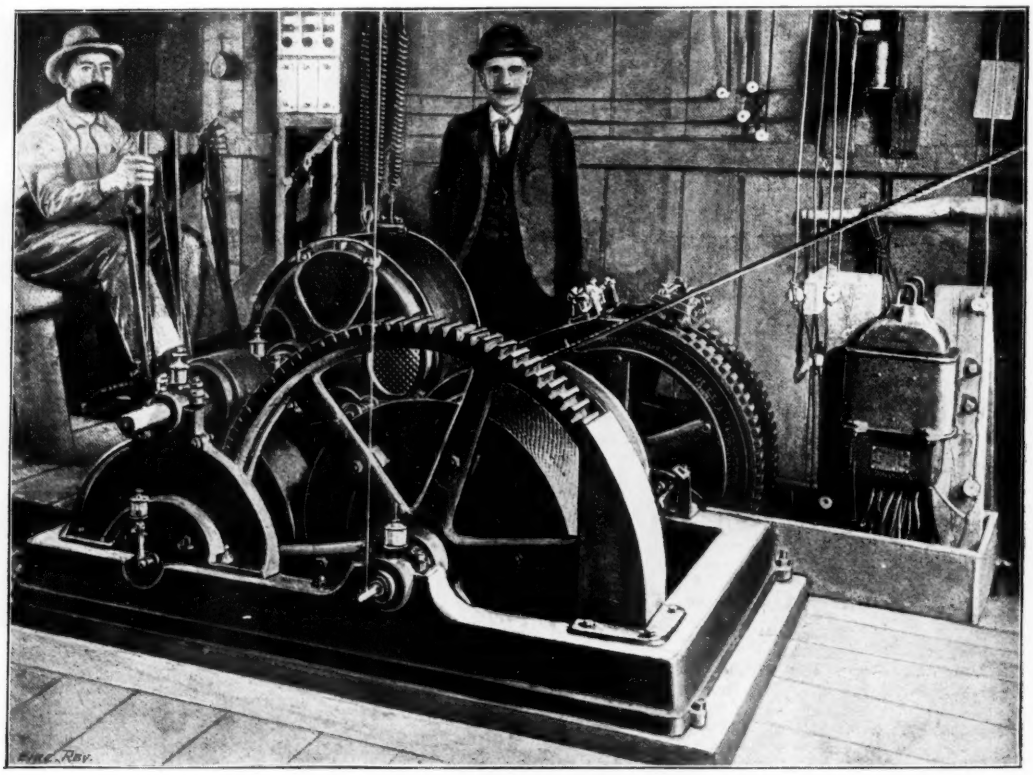


Fig. 2.—Electric Hoist at Wisconsin Mine.

upwards of $60,000 worth of machinery rented out, and is continually making additions.

The principal uses of electric power here are for hoisting and compressing air for the operation of machine drills. Air compressing in the large mines consumes about four times the amount of power required in any other service, for the reason that the compressor is worked almost continuously, while the hoist, though it consumes a large amount of power while in use, is in active operation less

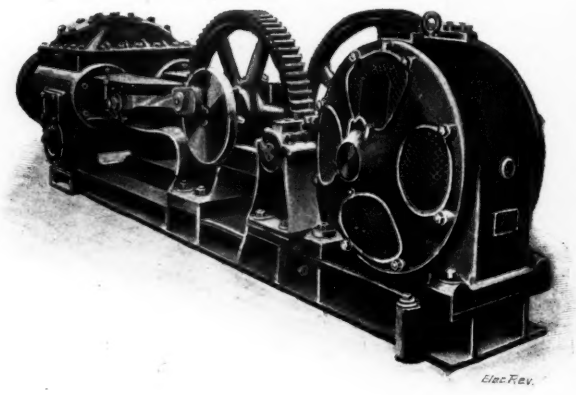


Fig. 3.—Motor Operating Pump.

than one-fourth of the time. Fig. 3 shows a Westinghouse electric motor operating a mine pump.

It is estimated that in the Cripple Creek District the use of electric power as compared with steam power effects a saving of from 15 to 50 per cent., according to the position and circumstances of the mine. This saving is irrespective of reduced wage account, and also irrespective of its greater reliability and convenience, since it is unaffected by frosts. Drills operated directly by electricity without the intervention of an air compressor have been in successful operation elsewhere in Colorado, though no such drills are as yet used in the Cripple Creek District.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 844.)

Surbiton.—The Ratepayers' Association has written asking the District Council for a copy of the agreement which the Council proposes "to enter into with Callender's, Limited, for the supply of electric light to the district." The request has been refused.

Torquay.—In connection with the recent electric lighting inquiry, it appears that a letter has been received informing the Corporation that the Local Government Board would not sanction the whole of the loan applied for unless further information was supplied showing how the money had been expended on the works. It is stated that the Local Government Board have only sanctioned the borrowing of £7,000 of the £10,000 applied for.

Twickenham and Teddington.—After a year or two in coming to maturity, a company under the title of the Twickenham and Teddington Electric Supply Company, Limited, intends applying to the Board of Trade for powers to construct the necessary works for the supply of electricity to the two parishes of Twickenham and Teddington. According to the terms of the draft Bill, only certain portions will be lit at the start, but powers will be asked to extend as need may arise.

Warlingham (Surrey).—The Council has been considering a communication from Edmundson's Electricity Corporation, Limited, *re* applying for a provisional order, and has replied that it is not itself applying for an order, and would not oppose the application if terms and conditions could be arranged.

Warminster.—At the last District Council meeting Mr. Trollope proposed that the electric lighting plant, purchased some years ago with the view of public lighting by electricity, and which had never been used, be disposed of. The matter was discussed at some length, and eventually it was decided to advertise the plant to see what could be obtained for it.

Weybridge.—A committee of the Council is considering a proposal of the Edmundson's Electricity Corporation to apply for a provisional order.

Withnell.—The District Council has resolved that the application for a provisional order for electric lighting be postponed. A sub-committee will continue the work, and draw up a scheme for lighting the district by electricity as soon as possible.

Worksop.—The District Council has resolved to adopt a scheme set forth in the report of the electrical engineer, estimated to cost £15,779, and that Mr. A. B. Mountain be retained to carry out the scheme.

Yarmouth.—The Corporation has decided to order a 150 KW. steam alternator, to cost £1,611, from Messrs. Willans and Robinson, and to enclose some land contiguous to the generating station at a cost of £250.

York.—The City Council has resolved that the price of electricity supplied to places of worship be 3½d. per unit, and has decided to extend the supply to the end of Barton Lane at an estimated cost, including mains for arc lighting, of £3,000. The electric lighting works are approaching completion.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Airdrie and Coatbridge.—For some time past the Town Councils of Airdrie and Coatbridge have been carrying on negotiations for promoting a tramway Bill in the ensuing session of Parliament. We are informed that for certain reasons Coatbridge now refuses to join Airdrie in the proposed tramway trust. The Coatbridge Town Council has discussed the situation, and in the end it was agreed to have the joint tramway and water scheme proceeded with in the form of a provisional order, on the understanding that they could arrange details amicably later on.

Barnes and Richmond (Surrey).—A newly formed company has notified its intention to apply for an Act of Parliament to enable them to lay down and maintain an electric tramway connecting Barnes with the Royal Borough of Richmond. The length of lines would cover several miles. They would start from Hammersmith Bridge, in the London County area, and proceed by way of Barnes Common and the river side, through Castlenaut, to Mortlake, and thence to Richmond Bridge. To enable the line to reach its objective point with facility, the promoters intend to undertake the construction of a new street in Richmond at the cost of several thousands of pounds, and also to give the Town Council and other authorities concerned easy terms on which the undertaking can be acquired.

Blackpool.—Mr. Quin's automatic cut-out, which has been described in the ELECTRICAL REVIEW, rendered good service one day last week when an overhead wire snapped. Current was immediately cut off, so that the falling wire was dead before it reached the ground and there was no danger to the public.

Blackpool and Garstang.—Notice is published in the Blackpool press to the effect that the Blackpool and Garstang Electric Light Railway Company, Limited, will apply to the Light Railway Commissioners for an order to construct and work light railways between these two towns. The proposal is to run over and use the ways of the Blackpool Corporation and the Blackpool and Fleetwood Tramroad Company by agreement.

Blyth.—A Newcastle paper says that the British Electric Traction Company is proceeding with the arrangements for an electric tram system for this neighbourhood.

Bournemouth.—We learn that the Town Council, after having for several years past offered strenuous opposition to companies that have proposed to construct tramways within the borough, has now adopted, by 15 votes to 3, a proposal to obtain powers to construct tramways over several miles of roads, under the Corporation's own control. The application of a private company, seeking for powers both inside and outside the borough, is to be opposed.

Bradford.—A Tramways Sub-Committee is to interview the Bradford and Bradford and Shelf Tramways Companies with respect to terms for acquiring the unexpired portions of their leases. The idea is to electrically equip the lines if the negotiations are successful. With the exception of the two new municipal electrical lines (Eccleshill and Great Horton) the Bradford tramways are leased until February 1st, 1903, to two companies.

Cambridge.—The Council last week approved of the acquisition of the tramways of the Cambridge Street Tramways Company, and the construction of farther tramways to be adapted for electrical power.

Cork.—At a meeting of the Judicial Committee of the Privy Council last Saturday at Dublin Castle, the Dublin Electric Tramways and Lighting Company, Limited, applied for an order authorising the construction of certain tramways in the County of Cork, which would be an extension of the tramways already constructed. The proposed line is intended to run along the Western Road and across the Wellington Bridge, both of which are in the county, and back by Sunday's Well, rejoining the city line. The Council granted the order asked for.

Devonport.—Construction of the Devonport and district tramways was commenced on Tuesday last week. It is expected to be completed by August next, and the Corporation hope by that time to be able to supply electricity generated by a temporary plant. It is certain that the proposed permanent generating station will not be completed by that time. The trolley standards are to be used by the Corporation for arc lighting purposes. There will be 30 cars.

Dewsbury.—The Corporation has decided to apply to the Board of Trade for a provisional order to construct tramways within the borough.

Driffield.—The Driffield Urban Council has discussed a proposal by a Manchester company to construct an electric railway from Driffield to Beeford (10 miles). The Council decided that it was unable to approve of the scheme until it had had an opportunity of considering the details.

Dudley and Sedgley.—At a meeting of the Sedgley Urban District Council last week, a report by the Tramways Committee was adopted, in which was a recommendation that an expert be employed to act on behalf of the Council, in order to see that the work of reconstruction by the British Electric Traction Company of the line between Dudley and Sedgley is properly carried out.

Dumbarton.—The Glasgow District Tramways Company have intimated that application is intended to be made to Parliament in the ensuing session to authorise the construction of electric tramways in Dumbarton.

Edinburgh.—The lessees of the tramways have resolved not to use electricity as the motive power on the Portobello route. The Corporation will now proceed with the erection of a cable power station for this route.

Folkestone, Sandgate, and Hythe.—*Herapath's Railway Journal* says that the South-Eastern Railway Company has in contemplation the construction of a new line from New Romney to Folkestone. The Sandgate and Hythe Electric Tramway Company, Limited, an offshoot of the British Electric Traction Company, Limited, is in the field with a proposal to run an electric tramway between the two places mentioned, passing through Dymchurch and Hythe, and crossing Shornecliffe Camp on its way to Folkestone Harbour.

Garston.—The decision of the Liverpool City Council not to continue the electric tramway along Aigburth Road, a distance of about two miles to Garston Village, has been followed by the formation of the Garston and District Tramways Company, Limited, who announce their intention of applying to the Board of Trade for a provisional order authorising the laying of a tramway.

Grimsby.—The Grimsby Street Tramways Company are applying for additional powers in the ensuing session of Parliament, under which they will use electricity as a means of traction, and will also extend their lines down Welholme Road, thus completing the circuit of the town.

Havana.—We read in a New York journal that the orders for the new electric railway system for Havana begin to mount up into large figures. Following the order to the General Electric

Company for the generating plant, &c., E. P. Allis & Co. now report that they have received an order for three direct driving vertical cross-compound engines of 1,600 H.P. each for the power house. Work is being pushed very actively, and nearly all the orders are for early delivery in 1900.

Leeds.—It is proposed to reduce the fares on the tramways with the introduction of the electric system on the Headingley and Chapeltown lines, which cannot be much longer delayed.

London.—A daily paper says that the South-Eastern Metropolitan Tramways Company has given notice of its intention to apply to Parliament in the ensuing session for powers to extend its tramways from the present terminus at the Black Horse, Catford, along the Bromley Road to Bromley, and along the Catford Road by way of Bell Green, Beckenham, and Anerley to Norwood. It is also proposed to construct connecting lines between Bell Green, Lower Sydenham, and the Crystal Palace, and from Catford Hill to Sydenham Railway Station. It is intended to construct the lines on the electrical surface contact system.

Manchester and Liverpool.—The promoters of this electric railway have issued circular letters to the owners of land at Eccles and Barton, situate between the highway and the Ship Canal, as a preliminary step in connection with the scheme.

Manhattan Elevated.—The Manhattan Elevated Railway Company has equipped experimentally with the third rail a section of its road at Third Avenue and Eighty-ninth Street. The *Electrical World* says that the third rails with which all the company's lines will be equipped are now in course of delivery under the contract made some time ago, but the work of placing them has not yet begun.

Mansfield.—The Council has considered a letter from Mr. C. H. Gadsby, engineer, Westminster, submitting an electric tram scheme proposed by his syndicate. The system would extend from Sutton-in-Ashfield, through Mansfield, to Mansfield Woodhouse, with a branch line along Chesterfield Road. The syndicate is to apply for a light railway order. The Council has appointed a committee to make inquiries and report.

The Mersey Railway and Electricity.—The *Times* records that the Mersey Railway Company intend to apply for leave to bring in a Bill to enable them, or the company and a joint committee, to work by electrical power the traffic on the company's existing and authorised railways, to light the railways and works by electricity, and to authorise the company, or the company and the joint committee referred to, to work by electrical power the traffic:—

(1) On the railways and stations vested in or under the control of the Mersey and Wirral Joint Committee; (2) on such portions of the Birkenhead Joint Railways of the North-Western and Great Western Companies as the company had, under an agreement, scheduled to and confirmed by the North-Western Railway Act, 1889, the right to run over and use; and (3) on the railways of the Wirral Railway Company. Authority will also be asked for to acquire patent and other rights and licenses in relation to the generation and use of electrical power; to constitute the intended generating stations, &c., an undertaking separate from that of the company. The Bill will also contain a clause to authorise the company or the joint committee to pay out of capital or out of revenue or any of their funds during the construction of the works for adapting the railways mentioned to working by electrical power, or during such time as may be prescribed by the intended Act, interest or dividend on any shares, &c., of the company or the joint committee to be created or issued for the purposes of the Act.

Musselburgh.—With regard to the proposed electric tramway between Portobello and Musselburgh, an agent of the company has attended before the Council and accepted its terms, upon which the promotion of a provisional order will be gone on with. The company had proposed to add in the cost of the unsuccessful promotion of the scheme as a light railway to the purchase price of the tramway as a going concern. The Council objected to this, but was agreeable to £350 being added, and the agent acquiesced.

Newcastle.—A deputation from the Town Council, consisting of Councillor Cail, chairman of the Tramways Committee; the burgh engineer, Mr. Laws; and the electrical engineer, Mr. Hopkinson, visited Glasgow last week, and inspected the electric tramways.

Oldham.—In the Corporation's new Bill to be presented in the next session is the following clause:—

Provisions for the widening of streets for tramway purposes by reducing the footpaths in certain cases, and for the attaching of brackets and wires to houses or buildings for tramway purposes, and in connection with the supply of electric energy.

Paisley.—The Glasgow District Council proposes to apply for powers for electric tramways for Renfrew, Paisley, Johnstone, and Lanark. It is stated that the scheme is introduced by Mr. Murphy, of Dublin.

Plymouth.—Considerable discussion took place at the last meeting of the Town Council with reference to a proposal by Mr. J. H. Rider to carry out the erection of the electric equipment of the Compton section of the tramways by means of workmen in the direct employ of the Corporation. The Tramways Committee approved of this, but as an amendment to their recommendation it was proposed that the electrical engineer should be instructed to prepare specifications of the work, that tenders be asked for, and that the engineer's estimate be presented in a sealed envelope with the other tenders. The mover of the resolution expressed his sympathy with the motion that the Corporation should as far as possible carry out work as the direct employer of labour instead of by the contract system, but said he thought they ought to have more information. Amongst others who supported the motion was the Mayor (Mr. Pethick) whose business is that of a contractor, and who pointed out that the estimate of the Corporation engineers was frequently exceeded when the tenders came in. In opposition to the amendment it was suggested that no contractor would tender under the conditions named, and as to the cost, they already had the engineer's estimate of £3,210. Mr. Rider explained that his proposal meant that all the material should be purchased by contract and that only the actual erection should be done by their own men. The present line to Prince Rock was practically equipped in this way, and it certainly was cheaper. The Council, however, decided by a substantial majority in favour of the amendment.

Preston.—The Town Council has resolved to promote a Bill to obtain powers relating to tramways and producing electric energy, &c.

Reading.—The Town Council has decided to apply for the necessary powers for instituting an electric tramway service forthwith.

Rhondda.—The Pontypridd District Council is engaging Mr. Pritchard, Westminster, at 10 guineas a day and expenses, to report on the feasibility or otherwise of erecting tramways within the district, as suggested by the British Electric Traction Company.

Rossendale Valley.—A committee of the Accrington Town Council has been considering proposals, made by the Accrington Steam Tramways Company and the British Electric Traction Company, Limited, for the extension of the tramway system in the Rossendale Valley. The chairman of the first-named company, in a letter addressed to the town clerk of Accrington, intimated that it was the intention, subject to terms being arranged with the Corporation, to work the two companies in conjunction, so as to provide for the inhabitants of the district a continuous and efficient tramway system from Bacup, through Accrington, to Clayton-le-Moors and Church. "It is intended," he said, "to apply for powers to extend the present systems to Rishton and Great Harwood (and probably in time to Whalley), on the one side, and to Helmshore, and in the direction of Ramsbottom on the other side. All these lines will centre in Accrington." It is proposed to adopt the overhead trolley system, and the Corporation is invited to carry out the necessary work upon all the lines now leased by it to the company, and to adopt them for electric traction, the company being granted a 21 years' lease upon terms to be arranged. The secretary of the British Electric Traction Company wrote as follows to the Corporation:—

In carrying out the proposed scheme, it will be necessary, as stated, to consolidate the Accrington and Rossendale companies. In doing this, however, it is our intention to retain the local character of the company, not only with respect to the name, but also in the constitution of the board of directors. Local representatives will be elected to seats on the board of the consolidated companies. . . . . In the case of the Oldham-Ashton, which was a new line constructed by us with the concurrence of the local authorities, we have entered into an agreement with the Ashton Corporation for the supply of current by them for the purposes of the tramways, similar to that proposed by the Accrington company, at a price of 1½d. per unit for a minimum of 850,000 units, and reducing to 1d. per unit as the supply increases. At North Shields again we made a similar arrangement with the Corporation, whereby they undertook to supply electrical energy for the tramways at practically the same rates as at Ashton. In most cases the Corporations have agreed that our engineer shall be consulted with regard to the plant installed by the Corporation for the purposes of the tramway supply.

The Legal and Parliamentary Committee of the Corporation decided that before definitely considering the proposals made it would be advisable to ascertain the views of the Haslingden and Rawtenstall Corporations as to the issues involved, and they accordingly instructed the town clerk to write to those Corporations, asking them:—

(1) Whether they would be disposed to join in the purchase of the tramways undertaking by each buying the lines in its own district and a proportionate amount of the rolling stock and plant. (2) Whether they would be willing to waive their respective paramount powers to purchase the lines in their own districts for 21 years in the event of Accrington Corporation agreeing to buy the whole undertaking and convert the system into an electric traction one. (3) Whether they would be prepared to waive their paramount purchasing powers for 21 years in case the Accrington Corporation agreed to extend the lease for a like period.

It is expected that a conference between the three Corporations will be arranged.

Stirling.—It is stated that an arrangement has been come to between the British Electric Traction Company and the Stirling and Bridge of Allan Tramway Company, under which the former takes over the tramways from Bridge of Allan to St. Ninians, subject to arrangements being made with the municipal bodies interested.

Surrey.—The Surrey County Council has adjourned for three months the proposals which their Highways Committee drew up for the construction of electric light railways in the county covering a distance of about 30 miles, and springing from Hammersmith Bridge as a common starting point.

A Tribute to the Trolley.—At Birmingham they have always had a remarkable antipathy to the trolley, not so much that they have any real knowledge against it worth considering, but æsthetic feeling at sublime Birmingham is very strong, and for years the opposition has been most determined in the Council. If impartial statements are to have any effect at all in settling the question, the following very excellent tribute from Leeds, appearing in the *Birmingham Argus*, ought to bring matters to a head:—

"Sir,—In reply to your letter of 10th inst., I have to inform you that the system of overhead electrical traction at present in operation in this city has proved successful and given satisfaction to the inhabitants, the electric cars being patronised in preference to horse and steam cars. The only route at present worked by the electric system consists of about eight miles of double track. Two other

routes have since been equipped, and it is hoped they will soon be opened for public traffic. I should add that at a meeting of the Council of this city, held on 4th ult., a resolution was passed that the system be applied to practically the whole of our tramways, about 53 miles reckoned as single track. I am informed that generally the system has not led to any depreciation in the value of property in its neighbourhood. So far as I am aware, it is not more dangerous than tramways generally are, and, as a matter of fact, nothing serious has happened up to the present.

"Leeds." "W. J. Jeeves, Town Clerk.

Twickenham and Hampton Court.—The London United Tramways Company are seeking for Parliamentary powers to construct an electric tramway from Brentford through Isleworth and Twickenham to Teddington and Hampton Court. This scheme is practically the same in respect of which they wanted a light railway order in the summer, but which was rejected owing to the opposition of the London and South-Western Railway Company, with which line it would compete. So far as the local authorities, through whose districts the line is to run, are concerned, they have already agreements with the promoters that they will assist the measure, the promoters in return making extensive alterations and improvements in main roads.

Walsall.—The Town Council last week considered the proposal to promote a Bill to give the Corporation power in regard to the tramways and other matters. The Bill will cover acquisition of tramways and applications for powers to extend the tramway lines in various directions, and also to work them. The Bill proposed to give the Corporation power to extend the lines as far as Walsall Wood in one direction, through Great Barr and Handsworth to Perry Barr in another direction, terminating with a junction with the lines of the Birmingham Central Company, near to Perry Barr Railway Station. A third extension proposed was to Willenhall, connecting there with the Wolverhampton tramways; and a fourth extension was from the present terminus at Bloxwich to the borough boundary on the Stafford Road. These extensions meant the construction of about 13 or 14 miles of tramway, and the total cost, including electrical equipment and cars, was in round figures from £100,000 to £120,000. The town clerk mentioned that a site for an electric generating station for the tramways had been selected, this being necessary to meet Parliamentary requirements. Among the other provisions in the Bill is "power to supply electrical fittings." The town clerk was formally authorised to take all necessary steps for the promotion of the Bill.

Warrington to Northwich.—Parliamentary powers are to be sought for the construction of an electrical railway between the above towns. The solicitor and the engineer of the scheme attended before the General Purposes Committee of the Northwich Council on Monday, and explained the proposal. The Committee approved of the undertaking.

Yarmouth.—The Town Council last week resolved to proceed with its electric tramway scheme, for which powers have been obtained to spend £55,000. The overhead wire system is to be adopted.

York.—The Council has decided to purchase the tramways company's undertaking either at once or in 1900 and 1902, according to the result of certain negotiations now proceeding. The idea is to have the lines extended and worked electrically.

TELEGRAPH AND TELEPHONE NOTES.

The African Trans-Continental Telegraph Line.—Reuter's correspondent at Abercorn (Rhodesia), writing under date September 2nd, says that the African trans-Continental telegraph line is at present only 15 miles from Abercorn, or 29 miles from Kituta, the south end of Lake Tanganyika. In the present scarcity of labour the chief of the construction, Mr. Fox, does not expect to get this small section of line finished for two or three months. From the *Times* we gather that the Tanganyika Concessions Company are going to put a steamer on Lake Tanganyika. She should be out in about three months' time and floated in about nine months. It is mainly for the transport of telegraph materials up the lake. The *Cecil Rhodes*, which presumably is the vessel referred to, was launched at Wyvenhoe on Saturday last. She will be employed primarily in laying the wires of the Cape-Cairo telegraph line along the shores of the lake.

Cable Interruption.—According to the *Levant Herald*, the submarine cable between Lattakieh and Cyprus has been damaged, and the Turkish Government has invited several European firms to submit estimates of cost for the repair or the renewal of the cable.

Cables for French Colonies.—From the *Morning Post* we learn that inspired, of course, by current events, M. Marc Landry, the well-known writer on Naval matters, is again expatiating on his favourite theme of the urgent necessity France is under of establishing direct telegraphic communication with its Colonies. In order to emphasise his arguments he prints two maps, showing how Great Britain has been "putting girdles round the earth," for half a century, while France has only two direct lines from Europe to the Western Continent, and another from Cape Cod to Hayti, continued to Puerto Rico, Guadeloupe, Martinique, and Cayenne, with small loop lines connected. M. Landry dwells strongly on the great advantages Great Britain has obtained by controlling all the news from South Africa, and asserts that the British are in a similar favoured position throughout the globe. Even French Colonies, like Madagascar and New Caledonia, he says, are under the control of British telegraph clerks. "What," he asks, "would be our situation in case of war with Great Britain? It would be only too simple. Great Britain would begin by cutting us off from our Colonies. After that she could disembark troops in them, concentrate squadrons, and bombard ports and capture our merchant ships without our being even able to warn our possessions of the imminence of hostilities. Is it not manifest that a Power that has a complete telegraph network will be mistress of the seas?" From all these facts M. Landry concludes that it is the duty of the Chambers to facilitate the creation of a system of French submarine cables.

In another place it is stated that recent events in the Transvaal have revealed to the French legislators the advisability of emancipating France from dependence upon English submarine cables, and the colonial group of foreign trade advisers decided last week, at M. J. Siegfried's suggestion, to impress upon the Government the necessity of prompt action in order to obviate the dangers of the situation. The authorities of Indo-China have decided to lay down a submarine cable between Saigon and Port Arthur. All the Indian Ocean and Pacific Ocean cables being now in English hands, France, in the event of war, would be at the mercy of England for the transmission of news.

The Rival Cables.—A Sydney paper has the following: "It has already been stated that at the recent conference between the Postmasters-General of New South Wales and Victoria it was agreed that if official recognition was given to the proposed Cape cable it must be on the understanding that there should be no undercutting of rates which would affect the business on the Pacific cable. The whole question, as to the influence this Cape project might have upon the Pacific cable, was discussed by the Ministers. The decision of the conference has been transmitted home by the representative of the Eastern Extension Company in Australia, with the object of ascertaining the views of the governor of the company on the matter.

The same paper also says:—

Sir Sandford Fleming has gone back to Canada, and it is understood that he is not at all satisfied, not to say grievously disappointed, with the results of the recent confabulations with the Imperial authorities on the proposed Pacific cable scheme. In these later discussions the Agents-General for South and West Australia have had no part—a peculiar fact, seeing that they were both assisting in the attempt on the Treasury which resulted in the offer of an annual subsidy from the Imperial Government. It would be interesting to know why Dr. Cockburn and Mr. Wittenoom were ignored.

For myself, I think that from an Australian point of view it would have been policy to have let the "All Red Cable" scheme lay dormant until Federation was an accomplished fact, and Australia could speak with one voice to the guardian of our national purse. That section of the British public interested in Imperial schemes now recognises that to be effective the all red cable must be duplicated, a fact which greatly increases the financial responsibility of the partners in its construction. They know also that at present Australia as a whole is not particularly keen upon the new line, and would like to be assured that when having, through Federation, obtained an interest in the South Australian trans-Continental line, the colonies which have been so eager for the construction of the Pacific cable will not modify their view as to the commercial worth of the "all red" route to them.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	June 30, 1899 ...	...
Trinidad-Demerara (1871 original)	Oct. 20, 1899 }	Nov. 9, 1899.
Do. do. (1891 duplicate)	Oct. 6, 1899 }	one cable restored.
South African:—		
Zanzibar-Mombasa	Oct. 27, 1899 ...	...
Cayenne-Pinheiro	Oct. 11, 1899 ...	...
Havre-Waterville	Oct. 25, 1899 ...	Nov. 19, 1899
Latakia-Cyprus	June 20, 1899 ...	...
Landlines.		
West Indies:—		
Cuban Government lines... ...	Oct. 30, 1899 ...	...
Communication with Jeremie and Port de Paix (Haiti)	Oct. 14, 1899 ...	Nov. 18, 1899
Communication with Les Cayes (Haiti)	Nov. 22, 1899 ...	...
South African:—		
Communication with Mafeking...	Oct. 13, 1899 ...	...
Communication with all offices beyond Orange River	Oct. 18, 1899 ...	...
Communication beyond Burghersdorp, Cape of Good Hope, and Estcourt, Natal...	Nov. 7, 1899 ...	...
Colombian Government lines to Bogota	Oct. 21, 1899 ...	...
Communication with interior of Colombia, excepting Amalfi, Ambalema, Buga, Cartago, Ibagua, Manizales, Medellin, Palmire, Pasto, Popoyans, Reimedos, Bonson, and Santo Domingo... ...	Nov. 6, 1899 ...	...
Communication with Valentia (Venezuela)	Nov. 18, 1899 ...	...

The Telephone Service.—The question of municipal telephones has been taken up at Bursiem. According to the *Municipal Journal* the General Purposes Committee of the Town Council has reported that at the recent conference of local authorities at Longton on the question of providing a cheaper telephone service, the principle of competition was agreed to be desirable, and it was recommended that a committee be formed to obtain information as to the practicability of establishing a cheap telephone service, either by combination of local authorities or by a company. Our contemporary says that at Glasgow matters have advanced another stage. The Postmaster-

General has asked that, in order to enable him to complete the license to the Corporation for the erection of a telephone exchange, he should be furnished with new resolutions of the various local authorities similar to those formerly passed. The burghs included in the area have been asked to comply with this request.

English Industrials, Limited, having written to the Withnell District Council regarding a proposed telephone service, that body has decided to give the company support and grant them wayleaves on terms to be arranged.

The York City Council is to apply to the Postmaster-General for a license to provide a system of public telephones.

The Moss Side District Council has approved of the proposal of the Mutual Telephone Company to apply for a license to establish telephonic communication in that district.

Telegraphic Communication with South Africa.—The postal telegraph authorities issued the subjoined notice on Monday:—

The Mozambique-Lourenço Marquez cable has been repaired, thus restoring communication with South Africa by the east coast route. It has been found necessary to suspend at Aden, as well as at the Cape of Good Hope, the transmission of all telegrams in code or cipher, whether of foreign Governments or private persons, to and from Zanzibar, Seychelles, Mauritius, Madagascar, British East Africa, German East Africa, Mozambique, Delagoa Bay, Rhodesia, British Central Africa, Orange Free State, Transvaal, Cape Colony, and Natal. Telegrams in plain language will be subject to censorship, and be at the sender's risk.

It is stated that the *Anglia*, cable ship, started on 19th inst. laying the new deep-sea cable from Capetown to St. Helena.

Wireless Telegraphy.—The *Scientific American* says that the director of the Meteorological Observatory on Mt. Blanc has been considering the advisability of installing the Marconi wireless telegraphy system upon the mountain. The ordinary system of telegraphy is used normally, but the great snow-drifts have played havoc with the telegraph wires. It is believed that the wireless system of telegraphy would prove not only valuable from a scientific point of view, but would also increase the safety of travellers upon the mountain.

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—December 4th. The Vestry wants tenders for arc lamps and posts. See "Official Notices" November 17th.

Birkenhead.—December 12th. The Corporation wants tenders for the supply of condensing plant, overhead crane, and feeder mains for the electric tramway works and scheme. See "Official Notes" this week.

Blackburn.—December 23rd. The Corporation wants tenders for overhead trolley line equipment. See "Official Notices" to-day.

Blackpool.—December 15th. The Corporation wants for the electricity works four boilers and accessorial steam plant; two 600-KW. steam alternators (or one 1,200-KW.), switchboard, mains, transformers, and battery. See "Official Notices" to-day.

Cork.—November 28th. The Committee of Management of the Cork District Lunatic Asylum wants tenders for fitting and lighting and driving plant, according to specifications to be seen at the office of Messrs. Hill & Son, 28, South Mall, Cork, or at Messrs. Edmundson's, Capel Street, Dublin.

Darwen.—November 27th. The Corporation wants tenders for one Lancashire boiler and accessories, one tramway switchboard. See "Official Notices" November 10th.

Denmark.—December 28th. The Corporation of Aarhus is inviting tenders for the water-tube boiler plant, steam dynamos and switchboard, accumulators for electricity works. From our "Official Notices," November 3rd, further particulars may be obtained.

Essex.—November 27th. The Governors of Felsted School, Essex, are inviting tenders for boiler, two 27-KW. steam dynamos, condenser, pipework, accumulators, cables, and switchboard for electric lighting. See "Official Notices" October 27th.

Gloucester.—December 28th. The Electricity Committee wants tenders for extension plant including Lancashire boiler, &c., one 300-KW. steam dynamo, switchboard work, condensing plant. See "Official Notices" to-day.

Hackney.—December 12th. The Vestry Electric Lighting Committee is inviting tenders for refuse destructors to deal with the whole of the refuse of the parish. Specification, &c., may be obtained at the offices of Mr. Robert Hammond, M.Inst.C.E.

Harrow.—December 4th. The Electric Light and Power Company wants tenders for a 150 KW. steam dynamo and switchboard extension. See "Official Notices" November 17th.

Lambeth.—December 6th. The Vestry is prepared to receive tenders for 25 arc lamps and posts. For particulars, see "Official Notices" November 10th.

Manchester.—December 2nd. The Tramways Committee wants tenders for 5,000 tons of steel girder rails and 250 tons of steel fish-plates. See "Official Notices" November 17th.

The Midland Corporation.—December 18th. From an "Official Notice" this week, particulars may be obtained of certain plant and machinery and conductors, for 10,000 B.H.P. output, required for the new power house to be erected by the Midland Electric Corporation for Power Distribution, Limited. There will be 16 water-tube boilers, six sets of Corliss engines and three-phase generators, transformers, switchboards, mains, batteries, &c.

Mistretta (Sicily).—December 31st. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Palermo, stating that tenders are invited by the Municipality of Mistretta, not later than December 31st next, for the establishment of a service of electric lighting in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Newcastle-on-Tyne.—November 30th. The Tramways Committee wants tenders for two 1,000-H.P. steam dynamos for electric tramway works. See "Official Notices" October 27th.

Port Alegre.—December 31st. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Minister at Rio, stating that tenders are invited by the municipality of Porto Alegre, not later than December 31st next, at 1 p.m., for the electric lighting of that town.

Plymouth.—December 8th. The Corporation wants tenders for tramcars, trucks, motors, trolley arms, &c. See "Official Notices" November 17th.

Rathmines and Rathgar.—December 13th. The Council is inviting tenders for additional feeding and distributing mains, including trenching, cables, joint boxes and house services. See "Official Notices" this week.

Stockport.—November 29th. The Council wants tenders for three-wire feeder cables and pilot wires. See "Official Notices" this week.

Weybridge.—December 4th. The Oatlands Park Hotel Company, Limited, wants tenders for wiring and fittings for 423 lamps at their hotel. See "Official Notices" to-day.

York.—December 4th. The Corporation invites tenders for the electric wiring and fitting of the Guildhall municipal offices and Mansion House. See two "Official Notices" in this issue.

CLOSED.

Darlington.—The contract for supplying the engines and electric lighting plant for the new installation at Darlington has been placed with Messrs. Ernest Scott & Mountain, of Newcastle-on-Tyne. Prof. Kennedy is consulting engineer. The work at present is not proceeding as fast as desired, pending the completion of the negotiations between the Corporation and the Imperial Tramways Company as to the supply of electric power.

Hammersmith.—At the Vestry meeting on Wednesday tenders, as under, for wiring and supplying fittings for the electric lighting of the Vestry's stables depôt, were received:—

Messrs. H. Beard & Co.	£165 0 0
Messrs. Russell & Russell	133 0 0
National Electric Wiring Company	197 17 0
Messrs. Peto & Radford	185 0 0
Messrs. Allen & Co	182 0 0
Messrs. A. Thatcher & Co.	153 17 10
Messrs. A. Hunt & Co.	168 10 0
Messrs. J. Bakewell & Co.	103 2 0
Messrs. Foote & Milne	129 0 0
Electrical Transmission Company	170 0 0
Messrs. Vaughan & Brown	165 10 0
Messrs. Newsome, Pinching & Co.	159 6 0
Mr. T. H. Hellyar	105 5 0
Mr. W. J. Adams	163 16 9
Mr. H. J. Godfray	168 0 0

The tenders were referred to Committee.

Llandudno.—For the supply of three high-speed engines and dynamos (150 KW each), motors, &c., for the District Council, the contract has been given to the India-Rubber Company, of Silvertown, at £4,020. The engines will be supplied by Messrs. Allen. Messrs. Babcock & Wilcox will supply a boiler at £1,200.

Swansea.—The Council has accepted the tender of the British Electric Schuckert Company for an engine and dynamo for the electricity works at £8,440.

Wigan.—The Town Council has accepted the tender of the E.P.S. Company for accumulators for the electricity works at £1,563. The Council is making application to the Public Works Loan Board for an £85,000 loan for electric lighting purposes.

FORTHCOMING EVENTS.

Friday, November 24th.—At 5 p.m. Physical Society. Agenda.—"On the Conductivities of certain Heterogeneous Media for a Steady Flux having a Potential." By Dr. C. H. Lees. "On the Thermal Conductivities of Mixtures and of their Constituents." By Dr. C. H. Lees.

At 8 p.m. Electro-Harmonic Concert, Café Monico, Regent Street.

Tuesday, November 28th.—At 8 p.m. The Institution of Civil Engineers. Papers to be further discussed:—"The Waterloo and City Railway." By H. H. Dalrymple-Hay, M.Inst.C.E. "The Electrical Equipment of the Waterloo and City Railway." By Bernard M. Jenkin, Assoc.M.Inst.C.E. Time permitting, paper on "Combined Refuse Destructors and Power Plants." By C. Newton Russell, Assoc.M.Inst.C.E.

Manchester Society of Junior Electrical Engineers. Meeting at Deansgate Hotel, Manchester. Paper by Mr. J. H. Henderson on "Aluminium, Its Treatment and Use, as Applied to Electrical Engineering."

Thursday, November 30th.—At 4 p.m. Royal Society anniversary meeting.

Tuesday, December 5th.—At 8 p.m. Northern Society of Electrical Engineers, Grand Hotel, Aytoun Street, Manchester. Paper on "Methods of Suppressing Arcing at Switch and Fuse Contacts," by E. K. Scott.

Wednesday, December 6th.—Institution of Electrical Engineers' annual dinner, Grand Hall, Hotel Cecil.

NOTES.

The Demand for Skilled Mechanics.—The Westinghouse Machine Company are advertising in American papers that they are enlarging their works and require skilled mechanics, &c. There may be nothing in this more than appears on the face of it, but it may mean that men are required for the new English works at Manchester. If these works are to employ 5,000 men, it is not easy to see how they can be secured except by special purchase on this side if the present condition of business holds out.

High Voltage Lamps.—Mr. A. H. Gibbings, in a letter to a contemporary, states that he considers 6 and 8 C.P. lamps for 230 volts to be as good in every way as the larger sizes, and that out of 800 8-C.P. lamps in Bradford not one has caused complaint since the pressure was raised in 1897. As the Bradford Corporation supplies lamps for renewal, free of charge, the staff has had occasion to make thorough tests of all kinds of glow lamps, as a result of which Mr. Gibbings says "there can be no question that at the present time the majority of manufacturers make equally as good, if not better, 200—230-volt lamps for all candle-powers than was the case when 110—115 volts was the standard voltage." The literal meaning of this remark is that manufacturers make 200—230-volt lamps now as well as, if not better than, they did some years ago, which might well go without saying. If, however, as we hope, and as the earlier part of his letter implies, Mr. Gibbings means that 200—230-volt lamps are as good now as 100—115-volt lamps were then, we must congratulate lamp makers upon the excellent progress which they have made in the interim.

Aluminium Electric Cable.—The *Electrical World* says that the Hartford Electric Light Company is just completing the installation of its aluminium cable between the new power house in Tariffville, on the Farmington River, and Hartford. The cable has seven strands and a diameter of three-fourths of an inch. It weighs about 1,500 lbs. to the mile, or nine tons for the whole line. The cable is not insulated, as is the copper cable which brings the 10,000-volt current from the Poquonock power house. The poles are short and very strong. No trouble is apprehended from weather conditions, as the cable is so light and strong that no amount of snow or ice which may accumulate on it in winter is likely to break it. The cable has been furnished by the Pittsburg Reduction Company, and its use in Hartford will, it is said, be the first practical electric test of aluminium on a large scale and over so long a distance.

Granite as an Insulator.—Granite is not usually considered to be an insulator, but one of the electrical journals reports that insulators are made as follows:—Maine granite is crushed and moulded into form and fused at 3,000° F. It resists all but hydrofluoric acid, and does not crush at a lower pressure than 14,560 lbs. per square inch, and gives a tensile strength of 480 lbs. per square inch; 56,600 volts were required to pierce ¼ of an inch of this material in the shape of cup insulators.—*Scientific American.*

Local Authorities and Telephones.—We cull the following from the *Local Government Journal*, again without comment:—

The attention of General Webber has been called to the paragraph headed "Sweet are the uses of Advertisement," in the last issue of the ELECTRICAL REVIEW, and he has reminded us that throughout the controversy in the past on the subject of the telephone the REVIEW has uniformly taken the side of ante-localisation, which view naturally the National Telephone Company strongly supports. The number of experts in telephone engineering are so very few that we think General Webber should be thanked for letting Municipalities and Local Authorities know that the advice he can give them, in a way second to none, is available—particularly, as he tells us that any preliminary general advice he may offer will be gratuitous—in view of the prominent independent position and interest he has taken up on the question from its earliest stages until now.

The Institution of Electrical Engineers.—The opening meeting of the session was held on Thursday of last week, when the premiums were presented to those to whom they had been awarded for papers read or published during the past session. The President announced that Mr. Henry Wilde, of Manchester, had donated £1,500 to the Benevolent Fund. Amongst those who had gained premiums were Messrs. McMahon, Duddell and Marchant, Oliver Lodge, Marconi, Young, and last, but, in the opinion of the meeting, by no means least, Mrs. Ayrton. Mr. J. W. Swan, having resigned the chair to Prof. S. P. Thompson, was awarded the usual vote of thanks. The presidential address will be dealt with elsewhere, so we need only say that it covered considerable ground and was full of terse and pithy hits at some of the weaknesses of the day—for example: "A grindstone is more likely to cause a fire than an alternate current motor, but there are no rules prescribed for enclosing grindstones." Mr. Gray proposed, and Mr. Mordey seconded, the vote of thanks to the President on his address. The seconder neatly summarised the address as a new feature, for the President took the *rôle* of a prophet, and spoke rather of the future than of the past. It was a fighting address, and he suggested that the rest of the session should be devoted to discussing it. The President gently vetoed this proposal, but as his interdict does not extend to technical journals, we have taken up the cudgels on our own account. The address will be valued as an able and critical survey of the present position of the field of electrical industry, and those who were unable to hear it delivered, although they will lose a good deal, will find it well worthy of perusal in cold print. Yesterday evening the meeting was to be devoted to mechanical and steam engineering questions.

Appointments.—Mr. A. G. Cooper, at present electrical engineer to Messrs. Davy Brothers, Limited, and formerly station superintendent of the Sheffield Company, has been appointed electrical engineer to the borough of Colne (Lancashire) to design and lay down a combined plant for electric lighting and traction purposes.

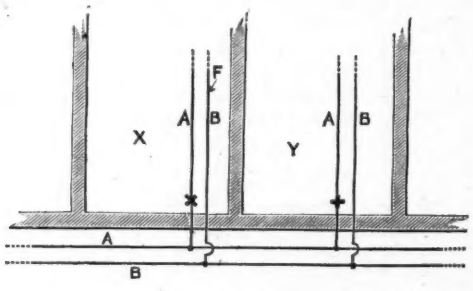
The recent advertisement for a second electrical engineer for the St. John Del Rey Mines in Brazil, elicited a large number of replies. Mr. W. C. Rooper wishes to state to applicants that the company have appointed Mr. A. J. Ewing, one of the assistant electrical engineers at the Elswick Works of Sir W. G. Armstong & Whitworth & Co., Limited, who applied through the advertisement in this paper.

Obituary.—The death is announced of Sir J. William Dawson, Emeritus Principal of M'Gill University. He was not only a teacher and administrator, but a diligent worker at more than one branch of geology, and the author of many books and of many contributions to scientific journals. He was knighted on the occasion of the visit of the British Association to Montreal, having received a C.M.G. two years before. He was a Fellow of the Royal Society in England, and first President of that in Canada, President of the American Association in 1882, and of the British Association in 1886.

Royal Society Medals.—We read in *Nature* that the council of the Royal Society has adjudicated medals for the current year as follows:—The Copley medal to Lord Rayleigh, F.R.S., for his contributions to physical science; a Royal medal to Prof. George Francis Fitzgerald, F.R.S., for his contributions to the advancement of physical science, especially in the domains of optics and electricity.

Warning.—Many of our readers have a very lively remembrance of the recent charge made against a "consulting engineer," who sought to attain certain ends by means of advertisements published in this and other journals. In order to place our readers well upon their guard, we feel compelled to utter a warning about another offending party. It is at the moment inadvisable to mention either the character of the offence, or the names of the delinquents, but we may just say that they are offering to do very big things for a comparatively small charge—things which our own personal experience in searching out information shows to be impossible at the price. If those who have lately had dealings with a suspicious firm up Manchester way will communicate with us, we will undertake to treat their letters with the strictest confidence and again communicate with them if thought desirable.

Earthing the Middle Wire.—A possible source of danger, due to the practice of earthing the neutral of a three-wire system, has been brought to our notice by Mr. Musgrave Heaphy, whose vigilance in the detection of fire risks is well known. Referring to the figure, where A and B are the street mains, of which B is earthed, X and Y are separate consumers (not necessarily adjacent), and F is an earth fault in X's wiring—suppose that X is taking a large current; then owing to the fact that the neutral is earthed at the station only, and that there is often a drop of pressure in the neutral, a considerable part of the return current may be shunted through the fault to earth, and it is easy to imagine conditions under which a fire would ensue. We have, in fact, seen a compo gas-pipe melted and the gas ignited, by an accidental contact between a lampholder of the old-fashioned type and a gas bracket. While an earth

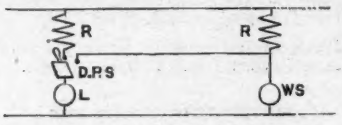


occurring on the *other* pole would immediately blow the fuse, the kind of fault suggested would not do so, and would therefore be all the more dangerous; further, as Mr. Heaphy points out, in some cases no switch is inserted in the conductor connected with the earthed main, so that, even if X opens his main switch, as shown in the figure, it is quite possible that Y may be using a large current, part of which will flow through the fault in X's premises as before, with the added risk that the latter may be unoccupied. The use of a double-pole switch in every consumer's main circuit does away with the last-mentioned danger, and should in our opinion be insisted on when one pole is earthed; but to guard against the first is more difficult. If the neutral were earthed not only at the station, but also at several points in the network, the fire risk would be eliminated, but electrolytic troubles would be brought on; possibly the cure would be worse than the disease!

Christmas Comfort for Tommy Atkins.—It is very pleasing to hear that the brave defenders of our honour in South Africa are being well thought of in connection with the approaching Christmas season. Among others we note the name of Messrs. Richard Johnson, Clapham & Morris, Limited, of Manchester, dynamo brush manufacturers, &c., who, together with their employés, are sending out 2,000 woollen and other comforters as a Christmas present for the men of the various Lancashire Regiments now engaged at Ladysmith.

Wireless Telegraphy.—A Laffan telegram from New York says that the Marconi Wireless Telegraph Company has been incorporated with a capital of 10,000,000 dollars.

The "Same Circuit" Method of Incandescent Lamp Photometry.—In the Electrical Review for October 27, p. 667, appeared an article on this subject which we reprinted from the *American Electrician*. The following letter has now been sent to that journal by S. E. Doane, of Marlborough, Mass.:—"I notice you mention the care that must be taken when turning off the lamp under test to prevent the diminished drop in the rheostat feeding the lamps from overburning the working standard. In practice a much more satisfactory arrangement than that shown in your diagrams has been developed, which consists in the use of two separate resistances, one for each lamp, and connected in series with that lamp as shown in the accompanying



R, R, Resistances; D P S, Double-pole switch; L, Lamp under test; W S, Working standard.

The Connection of Two Resistances and an Equaliser for the "Same Circuit" Method of Photometry.

figure. If, then, one lamp is turned off, the voltage on the other is not changed. The drawback to this method is that incandescent lamps, although supposed to be similar, are not exactly identical in resistance. Therefore this method of working would introduce an error wherever the resistances of the lamps departed from the average, due to the fact that the drop in one resistance would vary while that in series with the working standard would remain constant. This can be compensated for by putting an equaliser wire between the lamp terminals and arranging to have the circuit through this wire broken at the time the lamp being measured is removed from the socket. In central station work this can be done by means of a double-pole switch, as indicated in the diagram. In case rapidity in the measurement of a large number of lamps is desired, the insertion of the lamp to be tested can be made to close the equaliser wire circuit automatically and open it again when the lamp is removed."

Personal.—Mr. Claude W. Hill, who was for several years manager to Messrs. Paterson & Cooper, at Dalston, and has lately held the same position with Messrs. J. P. Hall & Co., Oldham, has been appointed London representative to the latter firm. Mr. Hill's address is Broad Street House, E.C.

Our trans-Atlantic namesake says that Prof. Henry S. Carhart, of the Department of Physics of the University of Michigan, who is absent on leave, is at the Physical Technical Institute, Berlin. He is comparing the electromotive force of the standard Clark cell with that of the standard cell of the Institute.

Prof. A. Jamieson returned some weeks ago from Cape Town, where he has been investigating a case of interference between the electric tramways and submarine telegraph cables. His evidence will be taken before a commission to-day at the Law Society's, Chancery Lane, and will be heard at the Supreme Court, Cape Town, in January.

Electrical Congress at St. Petersburg.—The first Congress of Russian electricians, convoked on the authority of the Ministers of the Interior and of Finance, will be held at St. Petersburg from December 27th to January 8th, under the auspices of the Société Imperiale Technique de Russie. The objects of the Congress are the promotion of intercourse between Russian electricians, the demonstration of the most recent electrical inventions, the study of the present state of the industry, &c. At the same time and place there will be held an exhibition of the most modern electrical apparatus, which will be international in character. Foreign exhibits will be admitted free of duty, on condition that they are removed from the country within one month from the close of the exhibition. Particulars of the regulations of the exhibition and of the Congress may be obtained from the committee of the Congress at the offices of the Société Imperiale Technique de Russie, Panteleimonskaja 2, St. Petersburg.

NEW COMPANIES REGISTERED.

Westmacott, Stewart & Co., Limited (64,160).—This company was registered on November 13th, with a capital of £60,000 in £1 shares, to acquire the undertaking and all or any of the assets and liabilities of A. Westmacott in connection with the business of "Vril Launches, Limited," recently purchased by him, and to carry on the business of launch, boat, car, carriage and vehicle manufacturers, electrical and general engineers, suppliers of electricity for light, heat or motive power, &c. The first subscribers (each with one share) are:—Alfred Westmacott, 62, Ashley Gardens, Westminster, shipbuilder; P. G. W. Westmacott, Rose Mount, Ascot, engineer; W. Burton Stewart, Hockcliffe Grange, Leighton Buzzard, underwriter; J. Westmacott, Widbury House, Ware, stockbrocker; W. H. G. Elliott, 94, Mallinson Road, Wandsworth Common, S.W., gentleman; S. H. Bath, Beech Villa, Geraldine Road, Wandsworth Common, S.W., clerk; and N. Chaplin, 19, Lincoln's Inn Fields, solicitor. The number of directors is not to be less than two nor more than five. The first are A. Westmacott, chairman, W. B. Stewart and J. Westmacott; qualification, £200; remuneration as fixed by the company.

Dublin Electric Lighting Syndicate, Limited (2,419).—This company was registered in Dublin on November 17th, with a capital of £5,000 in £1 shares, to carry on the business of an electric light and gas supply company and suppliers of motive power, whether electric, steam, hydraulic, gas, or otherwise, in all their branches. The first subscribers (each with one share) are:—Charles Wisdom Hely, Oakland, Rathgar, co. Dublin, J.P.; Vere Ward Brown, Balnagowan, Rathmines, co. Dublin, merchant; Henry Cochrane, 45, Kildare Street, Dublin, Knight, D.L., J.P.; John D. Wallis, 33, Bachelor's Walk, Dublin, carrier; John D. Chaytor, 30, Anglesea Street, Dublin, stockbroker; David Kellett, South George's Street, Dublin, J.P.; and Wilfred Fitzgerald, 17, St. Andrew Street, Dublin, stockbroker. The number of directors is not to be less than three nor more than five. The first are Sir Henry Cochrane, Knight, D.L., Charles Wisdom Hely, and Vere Ward Brown; qualification, £100; remuneration as fixed by the company.

SUPPLY STATION ACCOUNTS.

Sunderland Corporation Electricity Accounts.
Public lighting and private supply.

The accounts of the Sunderland electric lighting undertaking for 1898 cover the period of transition from a losing business to profit earning. Perhaps the most noticeable item is the enormous increase in units sold—over 200,000 in a total of 472,000. Not less satisfactory is the rise in gross profit. Probably the accounts will bear a still more favourable aspect when the new tramway scheme gets to work. Mr. J. F. C. Snell, the engineer for both the electric lighting and tramways, is, we believe, contemplating an extensive scheme of conversion from horse to electric traction, and the station costs, already good, should gain materially. The capital expenditure is low for the output, as will be seen from the general statement which follows:—

General Statement.

	1897.	1898.	Increase.
Total capital expenditure ...	£45,084	£61,931	£16,847
Number of units sold	270,352	472,240	201,838
Maximum KW. demanded... ...	361 KW.	424 KW.	63 KW.
Gross revenue	£4,251	£6,959	£2,708
Gross profit	£1,653	£2,854	£1,201
Average price per unit sold ...	3·00d.	3·41d.	−·19d.

There is a reduction in the returns from each item under the head of revenue per unit sold, the only important figure being nearly one-fifth of a penny on sale of current, the total being just under a farthing. At about 3½d. per unit sold it is evident that consumers have every reason to be satisfied, the margin between this and the works' cost of 2d. being almost wholly taken up in providing for sinking fund and interest.

Revenue Statement.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Sale of current	£4,051	3·69d.	£6,713	3·41d.	−·19d.
Meter rents	131	·11d.	187	·10d.	−·01d.
Supply of lamps, &c. ..	27	·02d.	15	·01d.	−·01d.
Sundry	42	·04d.	44	·02d.	−·02d.
Gross revenue ...	£4,251	3·77d.	£6,959	3·54d.	−·23d.

The costs of production show increases under the headings of "coal" and "oil, waste, &c." The fuel item suffers, we suppose, in common with works all over the country from the strike of last year and consequent scarcity which has left a stiffer market, even up to the present. Labour troubles are still hanging round the coal agent and colliery owner, and when we were told that at Sunderland the cost per ton had risen from 6s. 9d. to 8s. 9d., our only feeling was one of sympathy for those North Country engineers whose percentage coal bill is increased so much more in proportion than their Southern rivals, whose lamentations on the question of carriage and freightage charges may be modified by the thought that an increase of 2s. per ton will affect their costs per unit less when paying 16s. 9d. per ton than if they had been fortunate enough before to get their fuel for 6s. 9d. per ton. Water is costing 5d. per 1,000 gallons, to which ¾d. has to be added for softening, but Sunderland is again well off in comparison with many metropolitan works, who are mulcted at the rate of 8d. per 1,000 gallons.

Costs of Production.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Coal	£463	·41d.	£1,047	·53d.	+·12d.
Oil, waste, water and engine room stores.	128	·11d.	231	·12d.	+·01d.
Salaries and wages incurred in generation and distribution.	736	·65d.	1,040	·53d.	−·12d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	310	·28d.	464	·23d.	−·05d.
Works' cost ..	£1,637	1·45d.	£2,782	1·41d.	−·04d.
Rent, rates, and taxes ..	279	·25d.	311	·16d.	−·09d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	450	·40d.	719	·36d.	−·04d.
General establishment charges, stationery and printing, law charges and insurance.	232	·21d.	293	·15d.	−·06d.
Other expenses	...	...	...	...	...
Total costs ...	£2,598	2·31d.	£4,105	2·08d.	−·23d.

The net surplus of £352 has been carried to the general district rate account. The distribution of the gross profit is as follows:—

Profit Statement.

	1897.	1898.
Interest on loans	£1,051	£1,166
Sinking fund for repayments	1,205	1,336
Net profit, carried to rates	−603*	352
Gross profit	£1,653	£2,854

* Deficiency charged to rates.

CITY NOTES.

The Blackheath and Greenwich District Electric Light Company, Limited.

The directors' report reads as follows:—"The total expenditure to September 30th, 1899, as certified by the auditors, was £84,809 4s. 1d. The main buildings of the company's generating station at Blackwall Point are practically finished. They provide engine and boiler space for plant capable of supplying about 80,000 8-c.p. lamps on circuit. The chimney shaft will be adequate to meet future extension of the works. Generating plant of a capacity of about 50,000 8-c.p. lamps on circuit is now being installed. The contractors expect to have two machines at work at an early date. About 16 miles of the principal streets of Blackheath, Greenwich, and Lee have been opened up by the company, and 42 miles of cable laid therein. In Blackheath and Lee a temporary supply of electrical energy, obtained from a neighbouring company, has been available since July 18th last. The lighting of the district by electricity has therefore commenced, and will be speedily extended from the company's own station; 140 signed applications have been received up to October 31st last, equivalent to 6,896 lamps of 8 c.p., of which 3,625 were then connected to the company's mains. In addition, applications for motor power have been received to the extent of 40 H.P. The company's area of supply has been largely extended by the Lee (extension) provisional order, which the company promoted in the last session of Parliament, with the approval of the Board of Works, for the Lee district. The order empowers the company to supply electrical energy in those parts of the parishes of Lee, Eltham, Kidbrook, and Charlton, which were not comprised in the company's provisional order of 1897. A map showing the areas over which the company now holds Parliamentary powers is attached to the report. To carry out the provisions of the new order, and to complete the necessary extensions, further capital will be required by the company. The directors will shortly have to consider the question of raising such capital. The application made to Parliament last session by the County of London and Brush Provincial Electric Lighting Company, Limited, for powers to supply electrical energy in part of this company's area, was successfully opposed by your directors, acting in conjunction with other supply companies and local authorities interested. The company also successfully opposed the inclusion in the provisional order, promoted by the Board of Works for Lewisham, of the Blackheath portion of the Lewisham district comprised in the company's provisional order of 1897. Now that the works are approach-

ing completion it is the intention of the directors to make up the accounts to December 31st in each year, in accordance with the forms required by the Board of Trade, and to hold the annual meeting as soon as practicable after that date. The directors regret the death of their esteemed colleague, Mr. Thomas Evans. They have filled the vacancy thus created, and further strengthened the board by the appointment of Captain E. I. Bax and Mr. Henry St. John Winkworth. The board desire especially to acknowledge the assistance rendered by those of their colleagues who have placed their practical and expert knowledge of electrical works freely at the service of the board, and have thus given invaluable help in furthering the interests of the company. The rapid progress of the works is largely due to this assistance. Messrs. W. H. Pannell & Co. retire, and, being eligible, offer themselves for re-election."

Prospectus.

THIS week the list of subscriptions has been open from Tuesday until Thursday for an issue of 20,000 6 per cent. British Electric Traction Company cumulative preference shares of £10 each, offered at £12 per share by the Electric and General Investment Company. Out of 60,000 ordinary and 60,000 preference, 45,000 ordinary and 30,000 preference have been already subscribed, and £200,000 5 per cent. debentures issued. Our readers do not need to be told what the objects of the company are nor to have indicated to them the enormous amount of excellent projects it has in hand. A list of some of the principal undertakings in which it has a controlling voice is given in the prospectus, and notes of the profits for 1898 are stated, the directors adding that they are of opinion that the net profits for the current year will exceed the 1898 figures.

Official Announcements re Companies.

THE *London Gazette* contains notice to the effect that the following companies have been struck off the Register of Companies:—

British Electrical and Industries Company, Limited.
British Electrical Cycle and Motor Engineering Company, Limited.
Electrical Investments Trust, Limited.
Electric and General Exploring Syndicate, Limited.
Electric Transformer System, Limited.
Leatherhead Electric Lighting and Power Company, Limited.
Phœnix Accumulator Syndicate, Limited.
Practical Primary Electric Battery Syndicate, Limited.
Randall Telephone Syndicate, Limited.
Rottingdean Electric Lighting and Power Company, Limited.
South Manchester Electric Supply Company, Limited.
Walton-on-Thames Electric Lighting and Power Company, Limited.

Richmond Electric Light and Power Company.—It is announced that at a meeting of the shareholders of the Bournemouth and Poole Electricity Supply Company, Limited, held on Thursday, last week, the provisional agreement between the company and the County of London and Brush Provincial Electric Lighting Company, Limited, for the purchase of the latter company's interests in the Richmond (Surrey) Electric Light and Power Company, Limited, was duly approved.

Commercial Cable Company.—The directors have called a special meeting for December 4th, when authority will be sought to increase the capital to $15,000,000. It is proposed to issue $3,500,000 of the new capital to the present shareholders at par in the proportion of one new share for every three old shares. The object of the increase is "to provide an additional cable to meet the increasing business of the company."

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—W. T. Henley's Telegraph Works Company, Limited—further issue of 6,000 4½ per cent. cumulative preference shares of £5 each, fully paid.

Aron Electricity Meter Company.—A meeting of this company was held yesterday afternoon at Winchester House. A report will appear next week.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending November 18th, 1899, were £172 2s. 5d.: November 18th, 1898, £201 8s. 9d.; aggregate for half-year to date, £19,415 17s. 5d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending November 17th, 1899, were £4,897 13s. 3d.; corresponding period, 1898, £2,667 19s. 6d.; increase, £2,229 13s. 9d.

The City and South London Railway Company.—The receipts for the week ending November 19th, 1899, were £1,046; November 20th, 1898, £1,044; increase £2. Total receipts for half-year, 1899, £20,452; total receipts corresponding period, 1898, £20,403; increase, £49. Miles open, 8¼.

The Dover Corporation Electric Tramways.—The receipts for the week ending November 18th, 1899, were £159 8s. 0d.; November 19th, 1898, £150 9s. 11d.; increase, £8 18s. 1d. Total receipts to date, 1899, £9,149 14s. 11d.; corresponding period 1898, £7,652 12s. 9d.; increase, £1,497 2s. 2d. Miles of track open, 1899, 8; 1898, 8. Car miles run, 1899, 4,786, 1898, 4,363. Number of cars, 1899, 11; 1898, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, November 17th, 1899, were as follows:—D. U. T. Co., horse cars, £184 16s. 4d.; ditto, electric cars, £2,805 18s. 2d.; D. S. D. Co., electric cars, £699 19s. 6d.; total, £3,690 14s. 0d.; corresponding week last year—D. U. T. Co., horse cars, £2,295 7s. 2d.; ditto, electric cars, £333 4s. 3d.; D. S. D. Co., electric cars, £680 6s. 10d.; total, £3,308 18s. 3d.; increase, £381 15s. 9d. Aggregate to date, £85,670 10s. 10d.; aggregate to date last year, £82,212 11s. 9d.; increase to date, £3,457 19s. 1d. Worked:—The mileage open is 39 miles electrically, 5 miles by horses, as against 18 miles electrically, and 29 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending November 19th, 1899, were £571; November 23rd, 1898, £241; Increase, £337; Car miles run, 1898, 3,143. Number of cars, 1899, 23; 1898, 10. Total receipts to date, from April 1st, 1899, £20,044; 1898, from June 29th, 1898, £5,623. Miles of track open, 12; 1898, 3½.

The Liverpool Overhead Railway Company.—The receipts for the week ending November 19th, 1899, amounted to £1,438; corresponding week last year, £1,358; increase, £80.

The South Staffordshire Tramways Company.—The receipts for week ending November 17th, 1899, were £654 9s. 7d.; November 18th, 1898, £631 17s. 1d.; aggregate receipts for 46 weeks £30,749 16s. 9d.; 1898, £29,179 9s.

STOCKS AND SHARES.

Wednesday Evening.

PROMINENT among the features characterising the electrical markets this week is the District Railway disappointment. Frequent mention has been made in this column of the speculation in the stock engendered by reports of electric traction, and so on, but the reason for the rise is now stated to be the working union that is projected between the District line and the South-Eastern-cum-Chatham Railways. This is, the market considers, a disappointing consummation to the hopes that have been raised, and it is hinted that there may be other arrangements up the directors' sleeve which so far have not been disclosed.

In other electrical railway securities, the only move has been a rise of 5s. in Central London Deferred half-shares. It is thought probable that the near approach of the line's opening may be used as a lever for raising Centrals out of the comatose state into which they have relapsed for some months past. No change has taken place in Waterloo and City stock or City and South Londons.

The new issue of British Electric Traction Preference shares has had no effect upon the price of the Ordinary, but the existing Preferences have fallen a fraction, holders electing to sell these to pay for the new shares, for which they are applying at the issue price of 12. Could an allotment be guaranteed, the exchange would, of course, be an excellent one; but as it cannot, there is some element of risk in selling old Preference at the low prices now ruling.

The company's prospectus accompanying the particulars of the new issue is principally interesting as a proof of the enterprise and breadth with which the British Electric Traction is run. For anyone who can afford to hold them during the next few years, the shares are an attractive investment.

Supply shares—with the usual exception of London Electrics and South Londons—are hard, and in some request. It is the better class shares which are being bought—Notting Hill, Metropolitan, &c. The new shares of the latter company are now approximating very closely to the price of the old. City of Londons are ¼ better, but Charing Cross have not moved. The report from the Blackheath and Greenwich Company has not sufficed to raise the shares over par. Provincial shares are hard, and amongst those not mentioned in our regular list, on account of the limited market prevailing in them, we may instance Oxford Electrics, which are 7, Bournemouth and Poole, now 13, and the Preference shares of the last-named, which stand at 10½. The "Foreign" shares are quiet, Calcutta Electric at 5⅝ being slightly depressed by the fact that a call is pending (as is also the case in South London Electric Ordinary).

The tramway market presents few features. Anglo-Argentines are still sellers at 4, but Barcelonas keep firm at 13. We may mention that a well-known London banker is now making a tour through Spain, mainly with the idea of finding out what needs and what facilities there are in the country for electric tramways. His travels will probably bear fruit in the near future, for he is no novice in the economy of light railways.

Backed by ardent bulls, Anglo-American Telegraph stocks have again improved their position, the Deferred being more particularly to the fore. But fresh attention has been diverted to the South African telegraph lines, and now that the cables are once more in working order, Eastern Ordinary has been bought "on the war." The price, however, is still some 20 per cent. below the highest touched this year. Eastern Extension shares—"Chinas," as the Stock Exchange calls them—do not move, although, to keep their due relation to Eastern stock, they should be about ¼ higher than they now are. Submarine Cables Trust has advanced a point.

In the miscellaneous list, British Insulated Wire are harder and Edison & Swan are weak, competition being said to account for the latter.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Nov. 15th.	Closing Quotation, Nov. 22nd.	Business done during week ended Nov. 22nd, 1899. Highest.	Lowest.
124,400£	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	101	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
905,560£	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	65 — 69	66 — 69	68	67
3,047,220£	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	117 —118	117 —118	118	117½
3,047,220£	Do. do. Deferred...	Stock	...	...	18s. %	17½— 18	17¾— 18½	18⅜	17 15/16
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15 — 15½	15¼— 15¾	15 7/16	15 5/16
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	190 —200	198 —202	201	...
1,332,523£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	104½	103¾
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	1 %	¼— ¼	¼— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9 — 10	9 — 10	9¾	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20 xd	...	...
12,981	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	103 —107%	103 —107%	...	...
60,710£	Direct United States Cable	20	3 %	3¼ %	3½ %	12 — 12¼	12 — 12¼	12⅛	12 1/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	101 —104	101 —104	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	7 %	157 —162	158 —163	161	158
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	99 —102	99 —102	100½	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	... ...	... ...	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	117 —122	117 —122	120	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	15½— 16	15½— 16	16	15⅝
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
820,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	118 —123	118 —123	...	...
85,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 8,000, red. 1909	100	4 %	...	...	101 —104	101 —104	103½	101½
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	101 —104%	101—104% xd	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	5½ %	11¼— 11⅝	11¼— 11⅝	11⅛	11 1/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	15½— 16	15½— 16	15⅞	15⅝
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	30 — 32	31 — 33	...	...
89,500	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	48 — 52	48 — 52	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	106 —109	106 —109	...	...
71,000	Montevideo Telephone, Limited, Ord., Nos. 1 to 71,000 ...	1	...	...	...	¼— ⅜	¼— ⅜	...	...
84,000	Do. do. 5% Pref., Nos. 1 to 84,000	1	...	...	...	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	5½%	6 %	6 %	5 — 5½	5 — 5½	5½	5 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¼— 5½	5¼— 5½	5⅜	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100 —102	100 —102	101	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	¾— 1	¾— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	103 —106	103 —106	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
8,381	Submarine Cables Trust	Cert.	...	...	...	129 —134	130 —135	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	4⅞	...
151,783£	Do. do. 5 % Debs.	Stock	...	..	...	105 —108	105 —108	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	%	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— 1	¼— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	102 —105	102 —105	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	1 %	1%	...	1¼— 1⅝	1 — 1¼	1⅛	1 1/16
84,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¼— 10¾	10¼— 10¾	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	...	4 %	6 %	7½— 8½	7½— 8½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	10 — 11	10 — 11	10¾	10 1/16
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5¾— 6¼	5¾— 6¼	...	...
84,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	8 — 9	8 — 9	...	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	111 —113	111 —113	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	11½— 12	11½— 12½	12 1/16	11⅞
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	13 — 14	13 — 14	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	nil	10½— 11½	10½— 11½	10⅝	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	13 — 14	13 — 14	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	111 — 114	111 —114	112	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	...	5 %	7 %	5 — 5½	5 — 5½	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3¼— 3⅝	3 — 3⅛	3⅜	...
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6¼— 6⅝	6 — 6⅛	6½	6⅝
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	104 —106	104 —106	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	15 — 16	15 — 16	15⅝	15⅜
22,500	Do. Nos. 62,501 to 85,000	10	...	...	...	14 — 15	14½— 15½	15	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	...	117 —119	117 —119	118	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	15½— 16½	15½— 16½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	15½— 16½	16 — 17	16⅝	16½
30,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
65,000	South London Electricity Supply, Ord., £4 paid	5	...	...	...	3½— 4	3½— 3¾	3 9/16	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	14½— 15½	14½—15½	14¾	14½

* Subject to Founder's Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

† Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Nov. 15th.	Closing Quotation Nov. 22nd.	Business done during week ended Nov. 22nd, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	2⅜— 3¼	2⅜— 3¼	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	16½— 17½	16½— 17	17½	16½
30,000	Do. do. 6 % Cum. Pref. 30,001—60,000	10	...	...	...	13½— 14	13½— 13⅝	13⅝	13⅜
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	...	...	...	11 — 12	11½— 12½	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	...	...	...	6½— 6⅝	6½— 6⅝	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	nil	3 %	5 %	1⅞— 2⅛	1⅞— 2⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	4 %	6 %	6 %	2¼— 2½	2¼— 2½	2⅜	2 5/16
125,000‡	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —115	110 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½ %	15 %	13 — 14	13 — 14	13⅜	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	113 —116	113 —116	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	10½— 10⅝	10½— 10⅝	10⅝	10½
178,303	Do. do. do. £8 paid	10	...	...	...	...	...	...	...
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5½	4⅜— 5½	...	...
71,447	Do. do. Def. do.	5	...	...	...	5 — 5½	5½— 5⅝	5½	5 5/16
630,000‡	City and South London Railway	Stock	1 3/16 %	1⅞ %	2⅛ %	63 — 66	63 — 66	64½	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 ...	10	...	...	...	6½— 6⅝	6½— 6⅝	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3½— 4	3½— 4½	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½ %	6 %	6 %	2 — 2¼	2 — 2¼	2⅛	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½ %	6 %	6 %	4 — 5	3½— 4½	4 1/16	3⅛
344,023	Do. do. 4 % Deb. Stock Red. ...	100	...	...	...	95 — 97	95 — 97	...	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2 — 2¼	2 — 2¼	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	104 —107	104 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼ — ½	¼— ½	...	...
9,600‡	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	11 — 13	11 — 13	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	...	...	...	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	...	...	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	111 —114	111 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21⅜	21 1/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —104	100 —104	...	...
†37,500	†Liverpool Overhead Railway, Ord.	10	2½ %	3½ %	3½ %	9 — 9½	9 — 9½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13¼— 13¾	13¼— 13¾	...	...
†37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	37⅛	37
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	103 —106	103 —106	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¼— 9¾	9¼— 9¾	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5½— 6	5½— 6	...	...
540,000‡	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	101 —104	101 —104	102	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½% Debentures of £100, 105—108.
National Electric Free Wiring, 10s. paid, 5s.—7s.
Smithfield Market Electric, 1—3.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7⅛—8. Debentures, 104—107. Dividend, 1898, on Ordinary Shares 10%.
*T. Parker, £10 (fully paid), 18½.

* From Birmingham Share List.

Bank rate of discount 5 per cent. (October 5th, 1899).

MARKET QUOTATIONS, Wednesday, November 22nd.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a " Nitric .. .. .. per cwt.	22/-	22/-	..
a " Oxalic .. .. .. per cwt.	32/-	32/-	..
a " Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) .. per ton	£29	£29	..
a " " .. .. per ton	£27	£27	..
a Bleaching powder .. .. per ton	£6 1	£6 10	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. per gal.	7/-	7/-	..
a " (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. per ton	£25 10	£25 10	..
a Lead, Nitrate .. .. per ton	£25	£25	..
a " White Sugar .. .. per ton	£31	£31	..
a " Peroxide .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a " Caustic (76/80 %) .. per ton	£24	£24	..
a " Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a " Recovered .. .. per ton	£5 10	£5 10	..
a " Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a " Crystals .. .. per ton	£3	£3	..
a " Bichromate, casks .. per lb.	2¾d.	2¾d.	..
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£224	£224	..
b " Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£90 to £160	£90 to £160	..
c Brass (rolled metal 2" to 12") basis per lb.	8¼d.	8¼d.	..
c " Tube (brazed) .. .. per lb.	10d.	10d.	..
c " Wire, basis .. .. per lb.	8¼d.	8¼d.	..

METALS, &c. (*continued*).	This week.	Last week.	Inc. or Dec.
f Ebonite Rod .. .. .. per lb.	8/-	8/-	..
f " Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£85	£85	..
g " Wire (basis price) .. per lb.	10¾d.	10¾d.	..
g " Sheet .. .. .. per ton	£95	£95	..
g " Rod .. .. .. per ton	£85	£85	..
a German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	7/-	7/-	..
h India-rubber, Para fine .. per lb.	4/8 to 4/7	4/ to 4/6	inc.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i " Pig (Cleveland warrants) per ton	69/10d.	70/7½	9½d. dec.
i " Forgings, according to size per ton	From £11	From £11	..
i " Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i " Wire galvanised No. 8 .. per ton	£14 5	£14 5	..
g Lead, English Ingot .. .. per ton	£17 12 6	£17 12 6	..
g " " Sheet .. .. per ton	£18 16	£18 16	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£9 10	£9 7 6	2/6 inc.
d Mica (in original cases), small per lb.	2d. to 8d.	2d. to 8d.	..
d " " " medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large per lb.	3/6 to 7/6	3/6 to 7/6	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p " rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p " rl'd str'p & sheet per lb.	From 1/2	From 1/2	..
e Platinum .. .. per oz.	£3 11	£3 11	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£133 10	nominal	..
g " foil .. .. per lb.	1/6	1/6	..
n " wire Nos. 1 to 16 .. .. per lb.	1/11	1/11	..
p White Anti-friction Metals—	£38		
"White Ant" brand .. per ton	£40 to £70	£40 to £70	..
f Yarns, Cotton, Single 10lb. bundles pr lb.	7¾d.	7¾d.	..
j " Best Flax, 6 lea. .. per lb.	5d.	5d.	..
j " Hemp, 8 ply 10 lbs. .. per lb.	3¾d.	3¾d.	..
j " " Russian, 10 lbs. per lb.	4¼d.	4¼d.	..
j " Jute, 180 lbs. rove .. per ton	£14	£14]	..
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£26	£26	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

WATERLOO AND CITY ELECTRIC RAILWAY.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, November 14th, Sir Douglas Fox, president, in the chair, two papers dealing with the construction and equipment of the Waterloo and City Railway were read.

The first paper, by Mr. H. H. Dalrymple-Hay, M Inst.C.E, was devoted to a description of the general features of the line and the methods used in its construction. Since the opening of the Waterloo Station in 1848 various schemes have been considered for extending the London and South-Western line into the City, but none were feasible until the Greathead system was proposed in 1891. The new line was 1¼ mile long, and, with the exception of a short length at Waterloo, consisted of two iron tunnels with a station at each end, approached by stairs and inclines. The route taken from Waterloo was by Stamford Street, Blackfriars Bridge, and Queen Victoria Street to the City.

A stage with temporary shafts in the river at Blackfriars was first constructed, and on completion shields were set to work in both directions. Where the new line passed under the South-Eastern Company's viaduct at the centre of a 30-foot arch, the abutments were underpinned to the level of the proposed tunnels below, and a cross trench was sunk between the abutments and both tunnels driven towards Waterloo from that point. The tunnels between Waterloo and the river shafts were 12 feet 9 inches, and those between the latter point and the City 12 feet 1¾ inches, internal diameter. The larger diameter admitted of the carriages passing round 5-chain curves, of which there are four towards Waterloo.

The method of tunnelling in the London clay and in water-bearing strata was the well-known Greathead system, except in the case of a short length of tunnel which was driven by a new method not requiring the employment of a heading or timbers outside the shield.

At the City station, where the tunnels are 23 feet internal diameter, there was a scissors crossing near the West end to admit of trains arriving at or departing from either platform. At Waterloo there was a tail siding at the South end of the platforms, instead of a scissors crossing at the City.

The average rate of working in the small tunnels was 10 feet every 24 hours where the tunnels were in the clay. In the larger tunnels at the City station, which were also in the clay, 6 feet was completed regularly in the same time. In water-bearing strata, however, the speed varied greatly, depending upon the character of the ground and the depth of ballast and head of water at the face.

The iron segments of the small tunnels were erected by manual labour, but those of the large tunnels were erected by hydraulic machines fixed to the shield. The small tunnels were grouted with blue lias lime (three parts) to sand (one part), but the large tunnels were grouted with neat cement for the lower half, and equal parts of cement and blue lias lime for the upper half.

The work at Waterloo consisted of underpinning the existing piers of the arched viaduct upon which the South-Western station is built. The new station occupied two of the arches, and directly to the south of the platforms, but still under Waterloo station, it was necessary to introduce a cross-over road for the tail line, as there was not sufficient space for it between the south side of the station and the end of the company's property. This necessitated the removal of the central pier of the viaduct, and the substitution for it of a 40-foot arch with spandril walls to carry the old arches above. The repairing and cleaning sidings were in a depôt directly to the south of Waterloo.

On the northern side of Waterloo a short length of tunnel joining the up line with a lift had been constructed, and by this means the rolling stock and coals were lowered from the South-Western sidings to the tunnel below.

The second paper, by Mr. Bernard M. Jenkin, Assoc.M Inst.C.E, gave an account of the electrical equipment of the line, which was the second underground railway that had been built to be worked electrically. The electric energy was generated at the power station, at the Waterloo end of the line, by high-speed engines coupled direct to two-pole dynamos. The energy was transmitted to the trains by feeders connected to an insulated rail, or conductor, placed between the two running rails of the permanent way. This central conductor consisted of an inverted steel channel, carried on porcelain oil insulators, the top surface being level with the top of the running rails. The feeders and central conductor for the up and down lines were independent of each other, and should an accident occur on one line or in one of the tunnels it did not affect the supply of current to the other line or tunnel. There was an independent system of feeders and distributing mains for lighting the tunnels and stations. The trains were lighted from the circuit supplying power to the motors. The current from the motors and lamps was carried back to the power station by the running rails of the permanent way, which were bonded and connected in parallel throughout.

Each train consisted of two motor carriages, one at each end, and two trailer carriages in the centre between them. The motor cars were fitted with collector shoes, which rubbed on the top surface of the central conductor rail and carried the current from it to the motors driving the train. Each carriage was carried by two four-wheeled bogies, and one bogie on each motor carriage was fitted with two series-wound motors. Thus each train was driven by four motors in all, two on the front bogie and two on the last bogie in the train. The armature of each motor was built directly on the axle of the driving wheels, with the field magnets surrounding it fixed in position, so that they moved in a horizontal plane with the bogie, but could not rotate. No reduction gearing was used. There was a driver's cab in each motor carriage, placed over the bogie carrying the motors, in which was placed a controller and the necessary instruments for regulating the current to the four motors driving the train, and for reversing or connecting them as required, either all in series, or two in series in parallel with two in series, or all four in parallel. The two controllers were so made that that it was not possible to have more than one in use at the same time. The cables connecting the motors and controllers at opposite ends of the train were carried along the top of the cars outside the roof, and were connected by couplers between the cars.

The trains were fitted with Westinghouse compressed air brakes which could be worked from both ends of the train by valves placed in the driver's cabs. The pumps compressing the air were placed in the power station, and could be worked continuously to charge a reservoir from which the supply for charging reservoirs on the trains could be drawn as wanted. The reservoirs on the trains consisted of steel cylinders hung beneath the floor of the carriages, and were placed both on the trailer and motor carriages.

Experiments and tests had been made on completion of the line to ascertain the time and power taken to drive a train from one station to the other under different conditions and with different limits of speed on the sharp curves. The time in which a train could traverse the whole of the distance from one station to the other depended mainly upon the maximum speed which could be allowed on the sharpest curves. There were some very sharp curves at the bottom of the dip in the line where it passed under the river, and it was originally intended that the speed on these curves should be limited to 24 miles an hour. Before the line could be opened it was inspected by the Board of Trade, and Sir Francis Marindin decided to limit the speed round the sharpest curves to 15 miles an hour instead of 24 miles an hour, for which the whole of the electrical equipment of the line had been designed. This alteration had naturally a very great effect on the whole working of the traffic on the line, the brakes having to be applied to the train on the down gradients, as the speed which would be attained by gravity alone would very much exceed the limit of 15 miles an hour by the time the curves were reached. The switchback principle of working the line could not, therefore, be adopted as it might otherwise have been with the particular arrangements of gradients and the absence of intermediate stations which was the peculiarity of this line.

A complete system of block-signalling had been provided, and the shortness of the line made it necessary to place signals near the bottom of the dip close to the sharp curves referred to above. The position of these signals had an effect on the working of the line similar to the reduction of speed on the curves, as the speed on the down gradients had to be checked in order to enable the train to be brought to a standstill should the signal be against it.

A COMBINED TROLLEY AND STORAGE BATTERY LOCOMOTIVE FOR MINES.*

The numerous accidents to mules coming in contact with overhead trolley wires in mines have raised a demand for some sort of a system whereby the animal will become an unnecessary evil in the operation of a mine. To construct a bonded track and stretch a trolley wire to the face of all workings would be too expensive for general mine practice, and, in consequence, it is the custom in some mines to use a small mine wagon and have the miner push it to and fro from face to parting, from which place it is taken with the locomotive. In order to eliminate the mule from the mine and haul from the face of all workings, a combined storage and trolley locomotive has been devised, whereby the heavy work on headings is done from trolley, and while so running the attached battery, which is carried in circuit, absorbs sufficient current to do the necessary room work. Such a locomotive, the only one of its class, was built by the Baldwin-Westinghouse combination for the South-west Virginia Improvement Company, having the following dimensions:—

Gauge	36 inches.
Width over all	42 „
Height, including battery box	44 „
Length	124 „
Weight, including battery	9,000 lbs.
Electric equipment	2 10-H.P. motors.
Rheostatic controller.	

This locomotive was designed to haul on the level one loaded car weighing 9,000 lbs. on storage, and was accordingly equipped with 90 5-D. cells, and having mounted therewith a special battery circuit breaker, &c.

After the locomotive was built the mine manager changed his plans, and concluded to try it in a part of the mine where the battery would be required to handle loaded cars up a 4 per cent. grade and empties up 8 per cent. In addition, the trolley line was an extension of the feed line for some 10 or 12 mining machines, in consequence of which the voltage varied from 110 to 200, and the battery would either feed back into the line or throw the circuit breaker. In order to prevent the latter it was so adjusted that it would not fly out, and the battery was virtually short-circuited a large number of times each day without any bad effect. With this condition of affairs it was impossible to hold sufficient current in the battery to do the desired amount of room work, and it became necessary to stop a total of about 30 minutes each day for renewals. It must be remembered that this work was under the supervision

* Extract in the *American Electrician* from paper read by Harry K. Myers before the Engineers' Club of Philadelphia.

of a mine foreman unacquainted with storage batteries. Having gone to such extremes in the use of this locomotive it was suggested that a new and independent feed line would be a great improvement; it was installed, with marvellous results. The voltage became constant, and, the battery often discharged for a short time at three times its rated capacity; yet the work has been ideal, and after almost three months' service there is no appreciable wear on the battery. It produces a tractive effort up to the point of adhesion of the locomotive when working on storage, and the regular work is to take 17 empties weighing 60,000 lbs., including locomotive, from side track up a short 1 per cent. grade, then down a 4 per cent. to a level, from which place it starts to distribute in rooms having a maximum of 8 per cent. in favour of loads. After distribution it proceeds to collect the loads in trips of two cars each, on account of the 4 per cent. grade against loads on heading, and deliver them to the side track while working on trolley. In this manner this one locomotive is capable of delivering to this side track, over an average round-trip haul of 4,000 feet, 200 loaded wagons daily direct from face of working, which is the work, under existing conditions, of 12 mules and 8 drivers. It is the intention to place a night force, and if sufficiently large, the saving will be the care of 24 mules and time of 12 men, or an amount equal to $8,000 annually.

This same company has placed an order for six more of the same class of locomotives, and is considering the matter of constructing heavier ones of the same kind to take the place of steam locomotives now in use, but which are very injurious to both the ventilation of the mine and the timber work.

AMERICAN TRACK CONSTRUCTION.

When an American track departs from the usual practice of wooden ties, and the rails are laid on concrete, the method of work is as follows:—The trenches for the concrete are cut to a depth of 6 inches below the base of the rail. They are 20 feet wide at the top and 16 at the bottom. At intervals of 10 feet wooden blocks, 8 inches × 10 inches × 16 inches, are let into the trenches; the rails are spiked to these blocks, properly surfaced and put in alignment and true gauge. This done, the concrete is filled into the trenches and packed well up to the rail and up the side of the rail to within an inch of the bottom of the intended paving blocks. The rail joints, when to be cast-welded, are in the meantime held by temporary splicing. Rails are not less than 6 inches deep, and will be 9 inches on asphalted streets with stone toothing next the rails. Tie rods are 1 inch diameter, and are placed at 6 feet centres with double hexagon nuts to tightly clamp on the rail web, and the threaded end is long enough to enable a tie rod to be put in without bending.

For 80-lb. rails the cast joints weigh 150 lbs., and for 100-lb. rails they weigh 200 lbs., the cast metal being two-thirds pig and one-third scrap. It ought to be poured at a bright yellow, says the author of the paper under review, Mr. Ed. Butts, of Kansas City, but another speaker in discussion claimed at least a white heat as necessary. If the rail ends were carefully sand-blasted a perfect bond, electrically, would be formed. After the operation the rail surface is dressed off smooth, we believe with a portable emery wheel grinder. Paving should be the same as the rest of the street. Otherwise, if the track is paved on an asphalted street, heavy teams will follow the track, whereas if the track is asphalted on a paved street, light vehicles will overcrowd the track, and accidents are liable to be caused by any difference, leading to variation of traffic. The concreting is put round the rails before the welding is done, a space being left for the weld. The concrete holds the rail in place.

In Cleveland they found 12-bolt fish-plates to be more satisfactory than cast-welding. In Chicago, however, it had been tried as far back as 1895, and was still good, and the trouble anticipated by the Cleveland man, namely, failures due to expansion or contraction, had not been found to occur. He named several streets thus treated, including 10 miles on Halsted Street from Archer Avenue, where, we believe, "Dooley" lived in peace and war, to 79th Street. As much as 3,000 feet in one length had been welded, and had not failed in Kansas City.

We need not follow the discussion on "ties" or sleepers, and their material oak, chestnut, or hemlock. In this country we have no choice at present, and are confined practically to creosoted bodies in the very few cases where non-concreted track is used at all. As regards life of ties, we might name Jarrah and Ironbark, Australian timbers, which will last 25 years, and be sound even then. The timbers of Australia are too little known, and only lately have been used much in street paving blocks; notably, on Tottenham Court Road and Piccadilly Circus.

The general impression conveyed by all we can gather as to cast-welding is that it rarely fails if well and properly done. This implies thorough cleaning of the rail ends by sand blasting and the pouring of the metal at a white heat. It appears that even more reliable results would be obtained by a preliminary warming of the rail by means of a producer gas flame so as to mitigate the chilling effect upon the iron, of the cold rail. On English tramway work, exposed to about half the temperature ranges of America, and invariably bedded on concrete and buried up to the top of the rail, it certainly may be expected that even more satisfactory results will be obtained. We doubt if the temperature of tram rails in this country often falls below 32°, though information on the point is wanted. It was only in a very severe winter that water mains buried 18 inches frost up in London where the water in winter was practically at freezing point when pumped into the mains. Nor in summer time is it probable that rails ever approach the temperature of the air. In America it is common for the ground to be frozen several feet deep, while the summer temperature is equally severe the other way. Well bedded both in and on concrete, each unit length of rail is held against the stresses due to its own expansion or contraction, and heavy stress cannot take effect at weak points. There should be a future for cast-welding if only to save the establishment of a quiet corner in scrap copper.

A LARGE SUBMARINE TELEPHONE CABLE.

What is claimed to be the longest submarine telephone cable of its size in the world was laid a few weeks ago across the Straits of Mackinaw, from Mackinaw City to St. Ignace, by the Michigan Telephone Company—the Michigan end of the Erie Telephone Company. The *Electrical World and Engineer* says that the cable renders possible telephonic communication between the upper and lower peninsulas of the State. This heretofore has been impossible, with the single exception that Menominee, which is in the Upper Peninsula, just across the border from Wisconsin, has been reached by a very circuitous route around the southern end of Lake Michigan, *vid* Chicago and Milwaukee. The great copper country of the north, however, has been out of the telephonic reach of Grand Rapids, Detroit, and other points in the lower peninsula, and this undoubtedly has had something to do with the fact that Chicago and Milwaukee have virtually controlled the trade in various lines in Northern Michigan.

The cable is one of 20 "Simplex" strands, bound in tape and jute and armoured with No. 6 iron wires. Two of these conductors are larger than the others, and form the core; their conductivity is about that of a No. 8 wire. The other nine pairs—for the circuits are full metallic, and the conductors will be used in pairs—are equal in sectional area of copper to No. 12 wires. The outside diameter of the cable is about 2¼ inches. The cable terminals are in cable boxes mounted on poles on either shore of the straits, and the whole length is 5 miles and 175 feet. A representative of the company states that it cost $35,000, delivered at Mackinaw City.

Our contemporary says that after a week of preparation, which included the work of splicing the several lengths together, the cable was loaded upon a barge in tow of two tugs. A crew of 20 men was in charge of the work upon the barge, and the whole undertaking was under the personal supervision of Louis Hall, of Detroit, State superintendent of construction for the Michigan Telephone Company. The actual work of planting below the waters the great rope of insulated copper conductors was commenced on October 26th, and the trip across was made in a few hours. The greatest depth of water on the line surveyed for the cable was 256 feet. At 5 o'clock Thursday afternoon communication by telephone was had across the Straits of Mackinaw for the first time in history. A Western Union cable has been in operation at this point for some time, but that is all.

The expense of laying the new cable was very great. For more than a week prior to the day it was placed in the water the company was put to an expense of $80 per day for the tugs, and the labourers in the crew received $5 per day. They demanded this amount, and it was found more expedient to give it to them than to delay the work for the purpose of getting others to take their places. Of course, the salaries of the experts were much larger.

Six of the ten metallic circuits will be put into use as soon as the landlines on either side of the strait are completed. Some lines already reach Mackinaw, but others are being constructed, and the lines of the Upper Peninsula are being pushed forward with wonderful rapidity. Between Soo City and Marquette there are now working five crews of 50 men each. These crews have their camping outfits, special cars, and commissary departments. Another large crew is completing the lines this side of Mackinaw City. One of the six metallic circuits to be put into immediate use is for a local line connecting Mackinaw City and St. Ignace. The other four of the ten are a reserve to provide against possible needs in future.

CONDENSERS AND CONDENSING.

A paper on this subject, read by Mr. S. Payne before the Manchester Society of Junior Engineers, was needlessly prefaced by an apology for presenting the paper before electrical rather than mechanical engineers. Had the latter course been taken, this might well have been likened to taking coals to Newcastle, for the mechanical engineer of the kind evidently in the author's mind, has long since got beyond the stage of argument in respect of the advantage or otherwise of condensing. He never, at any rate, omits to condense if he has a supply of water at hand, though he may still be backward in the application of coolers or of evaporative condensers where water is scarce. But he never doubts the economy of condensing, as do so many electrical engineers, to whom a matter of 12 lbs. gratis mean pressure, or of an additional 200° of feed water temperature has no powers of appeal.

Taking approximate figures, the author points out that with an initial pressure of 80 lbs. absolute, and a cut off at one-third, the mean pressure is 41 lbs. Add a condenser and cut off at a fourth the stroke and allow 4 lbs. back pressure, and the mean diagram pressure will be 44·3, showing a steam economy of 25 per cent. and a power increase of 10 per cent. nearly—a total of 35 per cent. approximately, or, say, 30 per cent., not allowing for air pumps, &c.

Obviously, such a saving is not always to be effected, and if we

are to judge by many modern installations of condensing plant, we must confess that to us it appears that the capital account on the engine plant must have been nearly doubled, in order that by the use of auxiliary steam very wastefully applied, the main engines might be made to appear to save about the same amount as the auxiliaries waste. Properly applied, condensing will give great economy, but some modern condensing plant of the type that has grown up since the electrical business developed, is hardly worth the trouble it involves.

The author then gives a description of the ordinary jet condenser, and of the ejector condenser, the latter being useful where a free fall of water can be had under a head of 15 or 20 feet. The exhaust condenser is really an early type of the exhaust injector. It should be noted that there ought always to be an automatic check valve between the condenser and engine. Where a condenser can have a 34 feet down pipe to the hot well a small air pump alone is sufficient to remove the air, leaving the water to flow away by gravity. The air pump becomes simply what it is named. These barometric condensers may be used with circulating pumps, for the condenser vacuum helps the circulating pump at least to half the lift, but they are more properly applicable where a fall of water is constantly available and repumping is not called for.

Evaporative condensers act by the transference of the latent heat of the steam to be condensed to the water films upon the exterior of the condensing pipes, the heat so transferred becoming latent in the act of absorption and sweeping away of part of this water by air currents, often artificially set in motion by a fan.

Water-coolers are extended surfaces over which heated water is similarly cooled before being re-circulated through either jet or surface condensers, or even evaporative condensers.

Evaporative condensers are thought to lose about one-half to three-quarters of the weight of the steam they condense. They are thus capable of saving water not merely because they reduce the amount of feed-water necessary, owing to the economy of steam effected, but also because of the smaller weight of feed now wanted; they save a portion as compared with the non-condensing system of throwing all the feed away into the atmosphere.

In surface condensers, Peclet found that a square foot of copper plate would condense 21½ lbs. of steam per hour if supplied with water on the other side at 68° to 77° F. Ordinarily the cooling surface is one-eleventh of the weight to be condensed per hour, and brass tubes are preferred, as more durable.

As regards air pumps, we think a good deal of money has been wasted by the system of independent air pumps and condensers generally. We see no reason why high speed engines should not drive their own air pumps direct. Years ago we saw engines having a stroke of 5 feet or more, and running at 80 and 90 revolutions which drove their own air pumps from tail rods at this same piston speed of 800 to 900 feet per minute; and in air pump work it is perhaps less the speed of rotation than the bucket velocity that renders careful design necessary.

The author states that vertical air pumps are more efficient than horizontal pumps. Perhaps this is so where the horizontal pump bucket or plunger is run dry. But well-designed horizontal air pumps are drowned and do not leak air past their buckets.

Of modern air pumps, the author refers to the Edwards pump, an entirely novel design of great ingenuity, and one which has a future.

Cooling towers are referred to, the disadvantage of which often is that the water passed through them requires to be lifted through a considerable height, and power is thereby wasted. The Klein cooling tower occupies ⅓ square foot per I.H.P.

Oil separators are referred to. In some cases oil is separated from the steam in a chamber fitted with condenser plates, placed between engine and condenser. This has the advantage of keeping the condenser clean, but the author asks for the avoidance of cylinder lubrication as oil is very difficult to remove. This is a very lame and impotent conclusion at which to arrive. Oil can be perfectly removed from the condensed steam.

As it comes from the cylinder the oil is much emulsified. It is reduced to such minute particles that the difference of specific gravity between oil and water and the mutual attraction of the oily particles for each other are together insufficient to overcome the viscidity of the water, and time is required for the oil to float to the surface and coalesce. But the gravity effect can be increased by centrifugal action, and the Laval centrifugal separator acts as well on oil as it does on the fatty particles in milk. It separates any two liquids, not soluble the one in the other, with ease, by intensifying the difference of gravitation.

We think the author is wrong when he asks for the condensing plant to be split up into numerous units. We rather consider that each engine should have its own air pumps, but that one condensing main and one condenser might well serve several engines. A condenser big enough to serve a dozen engines will better serve one engine alone, but an air pump large enough for the dozen engines would be wasteful of power when one engine alone was at work. Obviously, therefore, air pumps may be many and condensers few.

Fire Tests.—An important series of fire tests with floors, partitions and doors, took place last week at the British Fire Prevention Committee's testing station at Regent's Park. Three of the tests were by French manufacturers. The French floors, partitions and girder coverings, made of a material called "Gypsine," were subjected to tests of an hour's duration, the temperatures ranging as high as 1,800° F., and followed by the application of water, the floors, of course, being loaded. Some oak and walnut doors were tested for 60 minutes at temperatures up to 2,000° F.

UNITS OF MEASUREMENT.

By W. MOON.

(*Concluded from page 787.*)

The present electro-magnetic units with their different units of intensity of magnetisation and of induction are very inconvenient to use and difficult to understand. Mr. Oliver Heaviside has long since proposed to do away with the multiple 4π and to make the intensity of magnetisation of the same value as intensity of field. I would go farther and propose to do away with the multiple 8π and to start the electro-magnetic system of units from unit induction equals unit stress across unit area. To define induction simply as the square root of the stress across unit area conveys a better impression of its nature, than to speak of so many lines of force or of induction. And if the electro-magnetic units were started from this definition the constant π would be eliminated from a number of formulæ in constant use, only to be introduced into a few seldom used formulæ for the action of magnets at a distance, to which it more properly belongs.

Such a definition as that of a unit magnetic pole might well be abandoned altogether; one has never to deal with an isolated magnetic pole, though sometimes with the moment of a magnet.

Starting from the unit induction as unit force across unit area, the definition of the other units follow:—Flux = induction × area; unit magnetic moment = unit torque experienced by unit magnet when at right angles to unit field.

Unit E.M.F. is produced in a circuit through which the flux increases or diminishes at unit rate.

Unit current = unit power divided by unit E.M.F.

Unit resistance = unit E.M.F. divided by unit current.

	Symbol.	Dimensions.	No. of C.G.S. units in proposed units.
Magnetic force ...	H	$L T^{-1} \sqrt{8\pi}$	2321×10^3 { H earth's field $= 84 \times 10^{-6}$ / B five proposed units = 11,600 C.G.S.
Magnetic induction	B	"	"
Flux	ϕ	$L^{\frac{3}{2}} T^{-1} \sqrt{8\pi}$	$\cdot 2321 \times 10^6$
Moment of magnet ...	M	$L^4 T^{-1} \frac{1}{\sqrt{8\pi}}$	$92\cdot32 \times 10^3$ moment of steel magnets about their volume.
E.M.F.	E	$L^{\frac{1}{2}} T^{-2} \sqrt{8\pi}$	$10\,745 \times 10^6 = \frac{1}{10}$ Daniell cell.
Current	C	$L^{\frac{3}{2}} T^{-1} \frac{1}{\sqrt{8\pi}}$	$923\cdot2 = 9{,}232$ amperes.
Resistance	R	$L T^{-1} 8\pi$	$11\,625 \times 10^3 = 11\cdot5$ B A microhm.
Specific resistance ...		$L^2 T^{-1} 8\pi$	$\cdot11625 \times 10^6$ { Copper = 014 units. / Mercury = ·84 units.
Inductance	L	$L 8\pi$	$251\cdot33 = \cdot25133 \times 10^{-6}$ henrys.
Quantity	Q	$L^{\frac{3}{2}} \frac{1}{\sqrt{8\pi}}$	$19\cdot94 = 199\,4$ colombs.
Capacity	K	$L^{-1} T^2 \frac{1}{8\pi}$	$1\cdot856 \times 10^6 = 1\,856 \times 10^9$ microfarad.
Current density ...		$T^{-1} \frac{1}{\sqrt{8\pi}}$	$9{,}232 = 600$ amperes per square inch.

As unit of supply the meg-unit of work could be taken, that is, 6 KW.-hours nearly. This unit would be a more convenient one than the KW.-hour, as it would make the prices of gas and electric light more comparable.

The taking of 10^6 units of time, that is, 6 hours, instead of the hour and the minute, would simplify many calculations, such as the consumption of coal in boilers and of gas in gas engines.

With the proposed units some of the electrical formulæ would be altered. The intensity of magnetisation of a bar magnet could be taken as its magnetic moment divided by its volume. If the flux in a magnet of unit length and unit moment were uniform from end to end of the magnet it would be but ½ a unit; but as this is never the case it is not evident that there is much advantage in making unit

intensity of magnetisation equal to unit induction, and to say that $B = \frac{I}{2}$ in the proposed units or $B = 4\pi I$ in the C.G.S. units is both inaccurate and misleading in the case of permanent magnets.

In electro-magnets $B = H\mu$ could always be used to the exclusion of the coefficient of susceptibility.

With the proposed units the magnetising force of a long solenoid would be

$$H = \frac{C n}{2 l},$$

and on a tangent galvanometer of diameter d.

$$C = \tan\theta \, H \, 2 d n^{-1},$$

and the inductance of a long solenoid would be

$$L = \frac{n^2 \text{ section } \mu}{2 l}.$$

In all three of the preceding formulæ the constant 2 would be omitted if 4π was eliminated from electrical formulæ instead of 8π. A reference to the table of electrical units will, however, show that the change from the C.G.S. system would be more troublesome if 4π was eliminated than 8π since the current and E.M.F. would not be so near decimal multiples of their present value.

On a tangent galvanometer, if H was adjusted to 100 micro-units by the use of a directing magnet and $d = 2$. c in micro-units would equal tan θ with 400 turns of wire.

The energy in unit volume of magnetised matter would be B H, so that with an endless solenoid

$$W = l a B H = l \phi H = \frac{\phi n c}{2} = \frac{L C^2}{2}$$

As a maximum energy in unit volume of magnetised iron, take $B = 5$, $\mu = 1{,}000$, then

$$W = \cdot0215, \text{ say, } \frac{1}{50}.$$

Steinmetz, formula for $\frac{1}{2}$ a cycle gives

$$W = \cdot56 \times 10^{-3} B^{1\cdot6} \text{ to } 2\cdot8 \times 10^{-3} B^{1\cdot6}$$

for average iron, say,

$$W = 10^{-3} B^{1\cdot6} = \cdot0132 \text{ for } B = 5.$$

Verdet's constant in quadrants and proposed units $= L^2 T^{-1} \frac{16}{\sqrt{8\pi}} = 14{,}771$. C.G.S. units with water and thalium light $= \cdot0693 \, B \, l$, where l is the length of water acted on.

The time of oscillation to and fro of a suspended magnet would be—

$$t = 2\pi \sqrt{\frac{I}{H M}}$$

and $$\frac{M}{H} = 8\pi r^3 \tan\theta$$

whence $$H = \frac{1}{t} \sqrt{\frac{\pi I}{2 r^3 \tan\theta}}$$

and $$M = \frac{\sqrt{32 \pi^3 r^3 I \tan\theta}}{t}$$

with an infinitely long conductor—

$$H = \frac{c}{\text{distance } 4\pi}$$

These formulæ for the action between magnets at a distance, and for that of a straight current on a magnet are but seldom used.

Any alteration in the present system of units used would necessitate the recalibrating of the voltmeters and amperemeters. But with the proposed units this alteration would be slight as they are nearly decimal multiples of the present units. An alteration in the figures on the dial and a slight re-adjustment would suffice.

The greatest difficulty would be experienced in the alteration of the resistance coils. But only a small proportion of the resistance coils in use are used for testing purposes and these alone would require re-winding.

The dimensions of the units most used would be

Magnetising force	... ...	in milli-units.
Magnetic induction	...	in units.
E.M.F.	... ...	in units or kilo-units.
Resistance, telegraphy	...	in meg-units.
„ electric light	...	in kilo-units or units.
Current, large dynamos	...	in units.
„ distribution	...	in milli-units.
„ telegraphy	...	in micro-units.
Inductance	... ...	in meg-units
Capacity	... ...	in 10^{-9} units.

It might at first be wished that the unit of current could be smaller and the units of resistance and E.M.F. greater. But on consideration it would not be desirable to depart from an easily understood unit of force to make the unit of E.M.F. larger than that given, nor is it desirable that the unit of current should be severed from the mechanical units to make it smaller, and surely it is in the natural order of things that a short length of wire should have its resistance expressed in units, while a long telegraph line should have a resistance of meg-units.

The electrostatic units are but little used; they would, however, be easier to understand if they started from unit stress per unit area giving unit E.M.F. per unit distance.

In the absolute electrometer

$$\frac{E}{l} = \sqrt{\frac{F}{\text{area}}}$$

$$= \sqrt{\frac{\text{L weight}}{\text{area}}},$$

so that in electro-magnetic measure

$$\frac{E}{l} = v \sqrt{\frac{F}{\text{area}}}$$

$$= 64\cdot885 \times 10^6 \sqrt{\frac{\cdot04577 \text{ weight}}{\text{area}}}$$

$$= 13\,885 \times 10^6 \sqrt{\frac{\text{weight}}{\text{area}}}.$$

The greatest value of $\frac{E}{l}$ that the dielectric strength of the air would permit of measuring is 10^6, so that with unit distance and unit area the weight would be about 5 grammes for that E.M.F.

The capacity of a sphere in electrostatic measure would be

$$K = 4\pi \text{ diameter},$$

and of two plates $K = \frac{2 \text{ area}}{l}$

and of two concentric cylinders

$$K = \frac{4\pi \text{ length}}{\log_e \frac{R}{r}}$$

dividing these values by v^2 to get electro-magnetic units,

$$\text{sphere } K = 2\cdot97 \times 10^{-1} \text{ diameter}.$$

$$\text{concentric cylinders } K = \frac{2\cdot97 \times 10^{-15} \text{ length}}{\log_e \frac{R}{r}}$$

$$\text{of two plates } K = \frac{\text{area}}{\text{distance}} \times \cdot2367 \times 10^{-15}$$

so that the capacity of a kilometre of cable would be about $\cdot125 \times 10^{-9}$ units, and of an aerial wire $\cdot005 \, 10^{-9}$ units.

STANDARDISING CARBON BRUSHES.

By E. KILBURN SCOTT.

Now that carbon brushes are becoming commonly used it is important that an effort should be made to standardise the sections. This is especially the case for those carbon blocks which are dovetailed into the brush holders. As things stand at present every firm, one might almost say every draughtsman, is getting out sections differing about a millimetre from those got out by someone else. As special tools are required for each size, the result is that it practically costs as much to equip a dynamo with carbon blocks as it

does to fit it up with gauze brushes, although when compared in the raw state the carbon is, of course, very much cheaper than either brass or copper. Take, for example, a carbon block with dovetailed head and measuring, say, $1\frac{1}{2} \times 1\frac{1}{4} \times 2$ inches long and weighing 3 ozs. In quantities of a few dozen each block will cost 1s. 2d., or at the rate of, say, 6s. per lb., whereas the cost of the carbon itself is less than about one-tenth of this. A block, $1 \times \frac{7}{8} \times 1\frac{1}{2}$ inches long, costs about 7d., and a block, $\frac{3}{4} \times \frac{1}{2} \times 1$ inch long, costs 5d.; these prices being for small quantities of, say, three or four dozen only. If the carbon manufacturers were able to turn out large quantities to certain standard sizes the prices would quickly come down, and in order to advance this desirable object the writer suggests that the following sizes be generally adopted :—

Carbons with Dovetailed Head.

Size.	A.	B.	C.	D.	Suggested length E may be sawn off to any dimension.
	mm.	mm.	mm.	mm.	
1	6	8	3	5	19 mm. ($\frac{3}{4}$ inch).
2	7	9	$3\frac{1}{2}$	$5\frac{1}{2}$	
3	8	10	4	6	
4	9	11	$4\frac{1}{2}$	$6\frac{1}{2}$	
5	10	12	5	7	
6	11	14	$5\frac{1}{2}$	$8\frac{1}{2}$	25 mm. (1 inch).
7	12	16	6	10	
8	13	18	7	11	
9	14	20	8	12	
10	15	22	9	13	
11	17	25	10	15	38 mm. ($1\frac{1}{2}$ inches).
12	19	28	11	17	
13	21	31	12	19	
14	23	34	13	21	
15	25	37	14	23	
16	27	41	15	26	51 mm. (2 inches).
17	29	45	16	29	
18	31	49	17	32	
19	33	53	18	35	
20	35	57	19	38	
21	38	62	20	42	63 mm. ($2\frac{1}{2}$ inches).
22	41	67	21	46	
23	43	72	22	50	
24	46	77	23	54	
25	49	82	24	58	

Plate Brushes for Traction Motors.

Length.	Breadth.	Thickness.	Nearest mm. dimensions. Length.	Breadth.	Thickness.
Inches.	Inches.	Inches.	mm.	mm.	mm.
$1\frac{3}{4} \times$	$\frac{3}{4} \times$	$\frac{7}{32}$	44	19	5·6
$1\frac{3}{4} \times$	$\frac{7}{8} \times$	$\frac{1}{4}$	44	22	6·3
$2 \times$	$1 \times$	$\frac{9}{32}$	51	25	7·2
$2 \times$	$1\frac{1}{4} \times$	$\frac{5}{16}$	51	32	8·0
$2\frac{1}{4} \times$	$1\frac{1}{2} \times$	$\frac{11}{32}$	57	38	8·7
$2\frac{1}{4} \times$	$1\frac{3}{4} \times$	$\frac{3}{8}$	57	44	9·5
$2\frac{1}{2} \times$	$2 \times$	$\frac{7}{16}$	63	51	11·0
$2\frac{1}{2} \times$	$2\frac{1}{4} \times$	$\frac{1}{2}$	63	57	12·7
$2\frac{3}{4} \times$	$2\frac{1}{4} \times$	$\frac{9}{16}$	70	63	14·3
$2\frac{3}{4} \times$	$2\frac{3}{4} \times$	$\frac{5}{8}$	70	70	15·8

Long Plate Brushes.

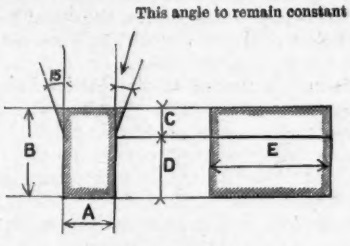
Length.	Breadth.	Thickness.	Nearest mm. dimensions. Length.	Breadth.	Thickness.
Inches.	Inches.	Inches.	mm.	mm.	mm.
$5 \times$	$1 \times$	$\frac{1}{4}$	127	25	6·3
$5 \times$	$1\frac{1}{4} \times$	$\frac{5}{16}$	127	32	8·0
$5 \times$	$1\frac{1}{2} \times$	$\frac{3}{8}$	127	38	9·5
$7 \times$	$1\frac{3}{4} \times$	$\frac{7}{16}$	178	44	11·0
$7 \times$	$2 \times$	$\frac{1}{2}$	178	51	12·7
$7 \times$	$2\frac{1}{4} \times$	$\frac{9}{16}$	178	57	14·3

In the case of the dovetailed carbons the dimensions are given in millimetres only, because, as the differences are small, it is more convenient than dimensioning in fractions of an inch. Several of the sizes in the tables are already standard.

Carbon brushes may be divided into two distinct categories:—First, those which have passed through an electric furnace on the Girard and Street process; and secondly, brushes which have only undergone baking in kilns in the ordinary way. The Le Carbone Company have given very great attention to the manufacture of carbon brushes, and that must be the writer's excuse for referring to their qualities only in the following notes.

In passing through the electric furnace electro-graphitic carbon brushes acquire a special texture, the molecules being, so to speak, soldered together by condensed carbon vapour, thus forming a mass similar to a substance heated to melting point. This reduces the contact resistance on the commutator and allows of its use (with the same degree of heating) for heavier currents than can be employed with ordinary agglomerated carbon.

There are two qualities of electro-graphitic carbon, viz.: "X" and "E G." The "X" quality has a resistance of 1,500 microhms per cubic centimetre, is particularly homogeneous, and keeps the surface of commutators on which it is employed in perfect condition. In normal work it may be employed for a current density of 15 amperes per square



Dovetail Brushes.

centimetre (27 amperes per square inch) of surface contact. The "E G" quality is also very homogeneous, but is not quite so hard as the "X" quality. Its resistance is about 4,500 microhms per cubic centimetre, and it can be used for a current density of 12 amperes per square centimetre (77 amperes per square inch) of contact surface.

Of the brushes baked in the ordinary way, a special quality, "Q S," has been supplied for some years. It is a uniformly dense carbon, and is suitable under normal conditions for a current density of 8 amperes per square centimetre (52 amperes per square inch) of surface contact. Its resistance is about 6,000 microhms per cubic centimetre, but for blocks of small dimensions this figure comes out rather lower.

All the above brushes are carefully made to gauge, but a cheaper quality, known as "F" carbon, is supplied, which is moulded by being simply forced through a die; an allowance of 2 or 3 per cent. must be made in the dimensions. The resistance of this material is about 4,500 microhms per cubic centimetre, and its normal working density 7 amperes per square centimetre (45 amperes per square inch) of surface contact. Generally speaking, this carbon answers well enough, and may be relied upon not to injure the commutator. It is very suitable for heavy current low voltage machines, and can only be supplied in large quantities.

The above current densities are the maximum that should be allowed. Of course the lower the density the better the result; about two-thirds of the above figures are recommended. On account of its high current carrying capacity the electro-graphite "X" quality carbon can frequently be successfully fitted to commutators which have been designed for metal brushes.

For the successful use of carbon brushes three points must be watched very carefully:—1. The connection between the carbon block and the holder and between the holder and the rocker stud must be above suspicion. For large currents flexible cables are absolutely necessary to connect the holder of the carbon block to the spindle on which it rotates. If the carbon block is large a hole may be drilled into it and the flexible soldered up direct, or the block may be cast into a white metal end having a stud projecting to which a cable eye can be bolted. Coppering

is advisable for blocks which are merely gripped between two surfaces, but care must be taken to strip the coppering well back, so that it does not touch the commutator. The expense of coppering ranges from ¾l. to 2d. each block, according to size.

2. The brush holder should be as light as possible consistent with strength (large sizes made of aluminium), and the spring should be adjusted so that the pressure is about 50 grammes per square cm. contact surface for electrographitic, and 100 grammes per square cm. for ordinary carbon, ·7 lbs. and 1·44 lbs. per square inch respectively.

3. The surface of the commutator should be dead true, it is not enough to merely turn it up, it should be gone over with an emery wheel or else lapped to a burnished surface. It goes without saying that the commutator segments should be held absolutely rigid by the micanite end rings.

UGANDA STATE RAILWAY TELEGRAPHS.

A French newspaper a few weeks ago described the progress of English railways in Africa as so rapid as to turn one giddy. However this may be in comparison with those of other countries, with the most important of them which starts from Mombasa in British East Africa, and will ultimately extend to the shores of Lake Victoria, progress has, as a matter of fact, been comparatively slow.

There are difficulties in this part of tropical Africa to be met with nowhere else, and a combination of some such as rugged country, dense jungle, waterless tracts, unhealthy climate, and absence of transport leads anyone with a knowledge of the matter to marvel that things have progressed as rapidly and as well as they have.

At the time of writing some 362 miles of rails have been laid.

The construction of the permanent telegraph line has naturally kept pace, but has not been carried ahead because of cost and difficulty in obtaining transport.

The materials for the line were specified by Sir Alexander Rendel, K.C.I.E, the consulting engineer to the Uganda Railway, in communication with Mr. B. T. Ffinch, C.I.E., of the India Office.

The following is a brief description of the most important items:—

Posts.—Cast-iron base, 7 feet long; flange at bottom 11 inches in diameter; metal nowhere less than ¼ inch thick; weight 195 lbs. Pole, 16 feet long; galvanised iron, tapered and butt-welded; metal not less than $\frac{3}{16}$ths inch thick; diameter at bottom 4 inches; weight 113 lbs; secured in base by a screw wedge.

Brackets. — Annealed maleable cast-iron, galvanised; weight 4·4 lbs.

Insulators.—White porcelain; weight 2 lbs.

Wire.—Galvanised iron, weighing 600 lbs. per statute mile; electrical resistance at 60° F. not more than 9 ohms per mile.

Up to the present two wires are erected. A third wire is in course of erection between Kilindini and Nyrobi, mile 326, and the ports, when placed 100 yards apart, are capable of carrying at least four such wires.

One of these wires is used exclusively for the signalling of trains by telegraph and the transmission of local telegraph messages. On it are the following stations, all of which are open for public work:—

	Miles.		Miles
Kilindini	0	Kibwezi	193
Makupa	2	Makindu	207
Changamwe	4	Simba	227
Mazeras	14	Sultan Hamud	246
Mariakani	23	Kimaa	255
Maji Chumvi	33	Kiu	265
Samburu	41	Machakos Road	274
Mackinnon Road	59	Kapite Plains	286
Maungo	83	Stony Athi...	297
Voi	100	Lucania	309
Ndi	109	Nyrobi	326
Tsavo	131	Kikuyu	327
Kinani	146	Ruaraki	345
Mtoto Andei	162	Lumoru	350
Darajani	173	Lari	357
Masongoleni	182	Escarpment	362

Kilindini Office is in connection with the Protectorate Post Office in Mombasa and also with the Eastern Telegraph Company's Station at Kilindini. With the latter direct working is carried on from Nyrobi, the headquarters of the railway.

The charge for messages all over the railway system is one rupee (1s. 4d.) for eight words. Names of sender and the address are sent free.

The second wire works from Kilindini to Voi direct with Mazeras in circuit, from Voi to Makindu, with Mtoto Andei in circuit, and from Makindu to Nyrobi with Machakos Road in circuit.

The third wire will work direct from Nyrobi to Kilindini.

With materials so substantial and of the highest quality, the maintenance of the lines naturally gives no trouble and is not likely to for many years. The wisdom of the 600-lb. iron wire throughout has been proved on more than one occasion when giraffes, which are fairly numerous in parts, have, in crossing the railway, somehow become entangled in the telegraph wires. Their frantic efforts, as evidenced on the ground, merely result in the wires being pulled out of level.

The posts, apart from their powers of withstanding corrosion, are not broken by zebra, wildebeest, and other animals galloping against them, nor displaced by the rhinoceros using them to rub himself against.

The instrument in use on the railway is the sounder, P.O. pattern, with No. 2 Leclanché batteries. The relays in use are the Siemens polarised.

Up to the time of the completion of the first 100 miles of line telephones were exclusively used for working trains and the transmission of messages. As many as seven worked on one wire, on the bridging system, with earth returns. The general direction of the line for this distance is from S E. to to N.W. No earth current was noticeable during the morning, but it began to be heard about noon, and increased during the afternoon until by evening speech was always seriously interfered with and was sometimes impossible.

Temporary Lines.

As has been stated, the difficulty and cost of transport prohibiting the erection of a permanent line, even of the lightest description, beyond Railhead, advantage was taken of the peculiarly dry climate from mile 100 onwards to erect an absolutely uninsulated and, for long distances, unpoled line of such length as has perhaps never been constructed elsewhere. The immediate need for an advanced line was the mutiny in Uganda, which broke out at the end of 1897, when the Railhead was at mile 103. Instructions were received from the Foreign Office to push a temporary line ahead, using what materials happened to be in stock. The bundles of 600-lb. iron wire, each weighing 100 lbs., were therefore divided into two of about 50 lbs. each, and a slack bight of some 10 feet in length left between them. They were then carried forward by every available porter, at the rate of about 14 miles a day, on an average, and at a considerable cost. A mile of wire thus took 12 porters. A quantity was also transported by bullock carts, but cattle disease stopped this much more satisfactory means of transport. As the wire arrived at its destination it was payed out along the caravan road and afterwards lifted by means of forked sticks on the tops of the trees and bushes forming the almost impenetrable jungle between Tsavo, mile 131, and Kibwezi, mile 193.

Further than this no progress was made for a time, it being impossible to obtain porters, despite the greatest energy on the part of the transport officer of the railway. Animals had by this time become almost extinct.

The working of this length of 62 miles by telephone gave no trouble. Occasionally in the early morning or during a shower of rain communication would fail, but never for more than a few hours at a time, and the line proved of great value both to the Protectorate and to the railway.

The first message it ever transmitted was one giving news of the escape of King Mwanga from German territory, and urging forward the progress of the Indian Regiment, which was on its way to Uganda.

The maintenance of this section was not difficult. There were few actual breaks, and the chief trouble was in keeping the wire clear of the road. Giraffes would cross and carry the wire from the trees on one side to those on the other, or

perhaps cause it to fall on to the road itself. Rhinoceros and other large animals would foul it in places where it was low, and though by the time they had pulled it taut they generally cleared themselves, sometimes they broke it. On one occasion when the maintenance party arrived at the scene of a break it found a rhinoceros still making hay with the wire, a length of which had become entangled on its horn. The members of the party betook themselves to neighbouring trees, and for some time remained impatient spectators.

A further extension was made to Nyrobi, mile 326, early in 1898. This point was then about 166 miles ahead of the rails.

Across the Athi plains no trees are to be seen, and there is little timber anywhere in the neighbourhood from which poles could be cut. Bamboos were therefore procured, and they were erected as tripods at intervals of about 160 yards all across. The bases of the bamboos were placed at the three corners of an equilateral triangle and about 10 feet apart. By the side of each a stout peg was driven into the ground, and to this the bamboo was secured by wire.

The height of the wire in the middle of the span was sufficient to enable the largest game frequenting the plains to pass safely under.

A few weeks after the completion of this part the rains came on, and as the grass grew game flocked in from the neighbouring country. The writer of this article rode for some 15 miles on his bicycle through one almost continuous string of zebra and wildebeest. Herds of these animals stampeding about at night, when frightened by him, soon knocked down most of the bamboos, and the wire left in places a few inches off the ground was broken by the next animal which passed. It was found impossible to keep the poles up, and the wire was ultimately taken down and left absolutely on the bare ground. In this position it gave no trouble whatever, and thanks to an abnormally dry season, the working proved satisfactory.

Controlling stations were established at Ngomeni, Kinani, Mtoto Andei, Darajani, Masongoleni, Kibwezi, Makindu, Kiboko, Muani, Kiu, Bondoni, Lucania, and Athi, at all of which places are either streams or water holes which enabled a good earth to be obtained.

In ordinary weather, speech was quite possible over a length of 110 miles, for 30 of which the line was on bare ground and the remainder on trees, bushes, and uninsulated poles cut in the neighbouring jungle. On further extension being required, hard-drawn copper wire, weighing 100 lbs. per statute mile, was procured, and this with little trouble was carried on to the Eldoma Ravine, about 150 miles distant, in a comparatively short time. Poles cut locally were erected all along the caravan road and the wire was secured to them with 3-ply tarred spun yarn. A length of yarn was wrapped round the wire so as to form a bed between it and the pole, and its ends were then crossed at the back of the pole and tied in front over the wire. In this way the wire is not in contact with the wood, and in wet weather there is probably better insulation, while any chance of damage by chafe is prevented. The intermediate stations between Nyrobi and the Ravine are, First Kedong, Naivasha, M'Baruk, and Molo.

The services of four Royal Engineer signallers having been secured from the War Office, Cardew vibrating sounders, as made by Messrs. Siemens Bros & Co., were set to work at the Ravine, M'Baruk and Naivasha and the Railhead station of the permanent telegraph lines. The other two intermediate stations are only for the purpose of controlling the maintenance parties. All stations on the temporary lines are open for public messages at the railway rates.

An alteration to this line was recently made, and the cleared railway route from Ziwani, through the Kikuyn forest, down the escarpment to the Second Kedong, is now followed, instead of the caravan road, thus opening up communication with the advanced earthwork parties of the railway. Trouble was here caused by elephants, which for some nights regularly rooted up posts which had been erected across a piece of open country near the escarpment.

There have been cases of cutting and stealing both of the iron and copper wire, but it is believed to have been generally done by passing caravans and not by natives of the country, who, as a rule, have a most wholesome respect for the works of the white man.

Energetic measures have been taken by the officials of the East Africa and Uganda Protectorates, and there is not likely to be any more trouble from this cause.

Instructions have been received to carry on this temporary line without delay up to Kampala, the capital of Uganda, distant from the ravine some 350 miles. This will certainly establish a record as a temporary line of the kind.

FRICTION LOSSES IN DYNAMOS.

In several of the simplest methods of determining the efficiency of dynamos, it is very desirable to know the friction losses; these losses are also the ones which are more likely to change in the course of time when the dynamo is in use; the laws concerning these friction losses and the determinations of their value are therefore of practical interest. A somewhat prolonged discussion concerning these losses has been continued in a number of issues of the *Elektrotechnische Zeitschrift*, and one of the results has been a long article by Mr. Dettmar, in which he goes into this subject very thoroughly and develops some points of practical value. The *American Electrician*, referring to this article, says one of the chief points which he brings out is that the loss of work due to friction is not proportional to the speed, as is often supposed, but that it increases quite appreciably with the speed; by this he refers to the sum of the various friction losses in the dynamo. This variation from a straight line law has been attributed to the air friction, but he shows that this is not correct, and that it is the coefficient of friction which is variable. There are three methods by which the friction may be measured, first by means of a calibrated motor, that is, driving the dynamo to be measured by means of a motor whose efficiency has been accurately determined. This method is not a good one if the motor drives through a belt, as that involves an unknown quantity in the form of the power absorbed by the belt; but if the machine is directly coupled the method is a good one though limited; the calibrated motor, for instance, should not be heavily loaded by the machine which it drives; the method has advantages when no convenient source of current is obtainable for the other methods. The second method is the well-known one of running the machine as a motor, unloaded; it combines great accuracy with relative simplicity. The third method consists in bringing the dynamo up to the proper speed either mechanically or electrically, and then letting it run down without doing any work other than overcoming the friction losses. The application of this method is, however, limited for absolute determinations, as it involves a knowledge of the moment of inertia, &c.; it is very serviceable, however, for determining relative values, that is, for comparing the losses at one time with those at another; moreover, the time required for making such a test is extremely short and this is of great value, as the other conditions, such as temperature, are not so likely to change during the test. If the losses are determined absolutely once for all, then the method serves very well for determining the condition of the bearings; moreover, by observing the action of the machine during the last turn before it stops, indications will be obtained as to the balancing of the armature. Sometimes the combination of two of these methods is of use, as, for instance, by using the first or second in order to find the absolute values of the relative ones given by the third method. In the third method, which he calls the "running down" method, a tachometer (this is an instrument for indicating the speed at any moment) must not be used, as that absorbs considerable power; in place of it the remanent magnetism may be used in connection with a voltmeter. The speed is measured once for all while running, and also the voltage at that speed due to the remanent magnetism; then the voltage readings may thereafter be used as a measure of the speed, correcting it, of course, by the factor thus determined. Otherwise a revolution counter, like a bicycle cyclometer, could be used. From this very lengthy series of tests Mr. Dettmar draws the following conclusions: At a constant temperature of the bearings and a constant specific pressure (that is, a constant pressure per square

inch) the friction coefficient, and therefore the loss of power by friction, increases as the 1·5th power of the speed. The nature of the oil used does not change this law but merely affects the absolute values. The values for this exponent, which he found for a very large number of tests, varied between 1·3 and 1·55, the smaller one being for a smaller machine and the larger one for those of larger sizes.

COST OF CENTRAL STATION PLANT.

(*Continued from page* 788.)

Overhead Traveller.—It has been suggested that in electricity works electric cranes should be used, and some few stations in this country have been so fitted. The use of the traveller in a properly equipped station is, however, so infrequent that a hand crane will do all that is necessary and it is much cheaper.

Boilers.—There will always be a considerable amount of controversy on the question of the type of boilers to use. The Babcock & Wilcox is a greater favourite than ever, but some engineers still think that for moderate pressure of, say, 140 lbs. per square inch, the Lancashire boiler cannot be beaten, whilst others advocate the Economic, Locomotive, or Marine. When everything is taken into account there is not very much difference in the total cost of the various types, so the figures given in the table may be taken as good covering prices without specifying details. The output of the two boilers should be equal to the three steam sets taken together. It is better to start with a relatively large size of boiler, so that the extensions can be carried out with the same size.

Economiser.—Green & Son have, until recently, monopolised all the economiser work, although all the really essential patents have long ago run out. In the near future there will be more competition in this class of work, but at the same time Messrs. Green & Son are to be congratulated on their record in the laying down of economisers. It is a splendid testimonial to the quality of their manufactures.

The Green type of economisers are usually built up of pipes 9 feet long and 4½ inches in diameter, and the price per pipe runs out at about 30s, this being inclusive of the dampers and electric motor for working the scrapers.

Steam and Exhaust Pipes, &c.—Piping work has on many occasions been a stumbling block for contractors, and there is a good opening for a firm to specialise on the supply and erection of piping for generating stations. Electrical engineering firms only undertake the work very occasionally, but with a firm doing nothing else, and having the proper kind of draughtsmen and erectors, we should be able to get down to something like bed rock prices. At present pipe contracts may run out at anything between £2½ and £7 per KW. of plant installed. The following rough make-up estimate may be useful as showing how the £1,000 given in the third column of the table is arrived at:—

Complete pipe arrangement, including steam and exhaust, feed and drain pipes, valves, joint rings, bolts and nuts, covering, hanger brackets, chequer plating to pipe chases, steam traps, &c. The whole arranged for three 90-KW. high speed dynamo sets, two Lancashire boilers, Green's economiser, feed water heater, two pumps and a water meter. The steam and feed piping to be tested to 350 lbs.:—

Steam Piping.—The steam piping to be of steel, arranged as a steam ring of 8-inch diameter pipes, with 3½-inch branches to the engines and 7-inch branches to the boilers. About 160 feet of straight steam piping at 11s. per foot run	£88
The bends of the steam piping to be of copper, with steel flanges screwed and brazed on. About 110 feet run of steam bends at 16s. per foot run	£88
Exhaust Piping.—The exhaust piping to be of cast-iron, 16 inches diameter, with 7-inch branches to the engines, and a 16-inch pipe carried up the chimney to a height of 120 feet. About 255 feet of piping in all at 12s. per foot run	£154
Feed Piping.—The feed piping to consist of 3-inch cast-iron piping with connections to two steam pumps, water meter, water heater, and economiser. The bends to be of copper. About 360 feet of piping in all at 1s. 6d. per foot run	£27
Valves.—The valves to consist of six 8-inch and three 3½-inch steam, three 16-inch and three 7-inch exhaust, also 20 valves 4-inch, 3½-inch and 2½-inch, for feed, &c. Steam and feed tested to 350 lbs. Say about 35 valves, all sizes, at £5 a valve all round	£175
	£532
To cover steam traps, water meter, drain pipes, chequer plates for pipe chases, hangers and brackets, packing rings, covering, bolts, nuts, washers, &c. Allow 33⅓ per cent. of £532	178
	£710
Special drawing office work, allow 7½ per cent. on £710	53
Erecting, &c., allow 33⅓ per cent. on £710	237
	£1,000

Water Storage Tank.—The water storage tank generally forms the roof to the pump room, and a usual size is 45 feet × 13 feet × 4½ feet deep. It is generally constructed of strongly bracketed plates with machined joints and the necessary facings for delivery pipes, &c. A water level indicator with pulleys, weight and chain, is fixed in a position where it can be readily seen, or a Bailey's pneumatic gauge may be used. A wrought-iron ladder to give access to the tank and a fire hose fixing are required.

Pumps.—The usual practice now is to put down a steam and an electric pump for the boiler feed, and to also fit each boiler with an injector. The tank is kept filled by means of a small electric centrifugal pump arranged with a float controller switch to start and stop the motor automatically.

Feed-Water Heater.—There are several makers of this useful piece of apparatus, and the quotations generally come within a few pounds of each other. The quality of the water is the principal factor in deciding on the type. The ingenious indented Row tube gives an enormous heating surface in little room, but with dirty water the older fashioned Berry heater would probably be preferable.

Engines. — The generating plant is divided into three units, as this is preferable to having only two generating sets and a number of spare engine parts, an armature, field coil, &c. In case of breakdown the station engineer should be in a position to get a new set to work at once and not have to wait until the broken part is replaced. The want of confidence, which is still characteristic of the general public of this country, is due in great measure to the niggardly way in which spare plant has been treated. The extension units of plant should be about twice as large as those first installed.

Some engineers still prefer to start up a station on the two-wire, and, as soon as convenient, change over to the three-wire system. If this is done, then the first dynamos laid down must be wound for 220 volts, and a balancer can, if preferred, be dispensed with. One method, which was first introduced at Lancaster, is to have a dynamo with two windings; another method introduced recently is to couple two dynamos to one engine; whilst another is to have the dynamos wound for the full 440 volts, and use a transformer temporarily to give the lower voltage. It is, of course, always possible to get any voltage from the cells by simply arranging them in the necessary order. Most stations nowadays start with a good load, and seeing the great advantage of automatic regulation which is given by the balancing transformer, perhaps the best way after all is to wind the dynamos for the full voltage of 440, have the battery arranged in two halves, one on each side of the middle wire, and depend entirely on a balancer for the regulation.

Theoretically the size of the balancer may be said to be equal to about $\frac{1}{10}$th of the running output of the station, but as small units are apt to be a nuisance afterwards, it is advisable to look well ahead when deciding on the size (this also applies to the booster), say, to the time when the station will have twice the amount of plant which is first laid down.

Balancer.—The output of the balancer may therefore be taken at $\frac{1}{5}$th of the running output of the station when first erected. Thus for 9,000 8-C.P. lamps fixed there are three dynamos of 90 KW. each, one being spare. Each side of the balancer will therefore be made large enough to deal with 82 amperes 220 volts = 18 KW. The question of whether to use two separate armatures or have two windings on a single core is generally answered in favour of the first method, because by having separate fields the two sides

may be easily and cheaply adjusted. A machine with the two windings on one core is, of course, cheaper so that if money is tight this gives an opening for a small saving.

Booster.—Since it was first introduced by Messrs. T. Parker, Limited, the method of separately boosting up the voltage for charging purposes has come rapidly into favour. It is undoubtedly the most scientific method, because speeding up an engine means poor governing, whilst a long range on the dynamo fields gives a more expensive machine and low efficiency when running on lights direct. One arrangement of booster is given by having a motor direct coupled to *one* dynamo, the cells being charged all in series, but two dynamos are generally coupled to one motor, the cells being charged in two sets. As in the case of the balancer, where there is one motor and one dynamo, the windings can be placed on a single core, this being cheaper as the armature reaction is neutralised. On account of the fixed ratio, however, the reduced voltage at commencing a charge has to be obtained by means of an expensive resistance in the main circuit.

Sometimes the balancing set and the booster are all coupled together, the balancing armatures acting as a motor for the booster. As many as four armatures are thus coupled in line, the two middle ones forming the balancer and the two outers being booster dynamos. This arrangement gives a long straggling piece of apparatus very liable to vibrate badly, and probably the best method is to have the two machines entirely separate.

Switchboard.—From very small beginnings the switchboard has grown and grown until it is now relatively the most expensive piece of apparatus in a central station, there is, in fact, a distinct tendency to go too far in this direction of elaboration. In the opinion of some the ideal arrangement is a skeleton board such as is in use at Manchester. It does not look pretty, but there is a utilitarian appearance about it which appeals to the engineer.

The board should be placed on the wall of the engine house with a room—preferably the testing room—immediately behind so that there is good daylight on each side.

A switchboard for a continuous current three-wire system, 220-volt lamps, with three generating units and, say, five circuits, and costing, say, £1,000, would be made up somewhat as follows:—

Dynamo panels	£200	
Feeder panels	300	
Balancer booster panel	100	
Battery panel	50	
		£650
Main switchboard connections including those between board and machines		100
Works' switchboard for lighting and power		75
Wattmeters and recording voltmeters		100
Erection on site		75
		£1,000

As a rough guide the following figures may be taken:—

£2·8 per kilowatt of plant installed.
£1·2 per point or per connection on the board.
£4·6 per square foot of superficial area including frame.

(*To be continued.*)

Electrostatic Measuring Instruments.—For many practical reasons, electrostatic instruments offer pre-eminent advantages in the measurement of high pressures; they suffer, however, from the tendency to spark across, on account of which the parts have to be placed so far apart as to greatly weaken the measuring forces. According to the *American Electrician*, Prof. Elihu Thomson proposes to overcome this difficulty by enclosing the instrument in a glass bulb, exhausted of air to a very high degree, so that the sparking distance for a given pressure is very much reduced. The vanes and quadrants can then be brought very closely together with safety, greatly increasing the sensibility of the instrument and reducing frictional errors, while the whole instrument can be of stronger construction. The pointer and scale are, of course, enclosed in the bulb, as well as the inductors, &c. The device is covered by a patent, which broadly claims the enclosure of measuring instruments in vacuo.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS. 1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

22,143. "Improvement in electrical accumulators." E. C. H. T. Lugard. Dated November 6th.

22,163. "Improvements in continuous current electricity meters." E. Schattner. Dated November 6th.

22,164. "Electro-magnetic ignition device with revolving armature for gas petroleum and similar motor engines." W. P. Thompson. (F. Sturm, Germany.)

22,181. "Improvements in or relating to electric taxameters." E. Johansson. Dated November 6th.

22,212. "Improvements in electric switches." C. Wood. Dated November 7th.

22,260. "Improvements in and relating to submarine telegraphy and apparatus for use in connection therewith." H. H. Lake. (J. B. Millet, United States.) Dated November 7th. (Complete.)

22,267. "Improvements in or relating to electric light fittings." H. Hill. Dated November 7th.

22,271. "Improved manufacture of electrical heating appliances of high electrical resistance capable of sustaining high temperature." A. Vogt. Dated November 7th.

22,291. "A new or improved system of telegraphy." J. G. Lorrain. (F. Bedell, United States.) Dated November 7th.

22,293. "Improvements in electric traction." W. A. Burns and H. E. Smith. Dated November 7th.

22,297. "Improvements in roller gearing and transmission dynamometers." T. Foster. Dated November 8th.

22,298. "Improvements in and connected with electric railways or tramways." T. Scott. Dated November 8th.

22,303. "Improved means for guiding collecting trolleys on to overhead electrical conductors." I. Dixon. Dated November 8th.

22,306. "Improvements in and relating to electric arc lamps." C. C. Ridings. Dated November 8th.

22,308. "Improvements in telephone switchboard cable." A. Whalley. Dated November 8th.

22,313. "Governor relay or speed controller for steam engines, especially adapted for controlling large engines for electric light and power stations." R. Wilby. Dated November 8th.

22,317. "Improvements in electric arc lamps." C. Curwen. Dated November 8th.

22,343. "Improvements in central battery telephone exchange systems with call wire." P. H. Cole. Dated November 8th.

22,333. "Improvements in electrical switches." Evered & Co., Limited, and S. Evered. Dated November 8th.

22,334 "Improvements in and relating to chemical electrical excitants." J. Post. Dated November 9th. (Complete.)

22,517. "Electrical influence machines." W. R. Pidgeon. Dated November 11th.

22,531. "Improvements relating to electric igniters." A. H. C. Gibson and W. Wright. Dated November 11th.

22,525. "New or improved means for placing, removing, and cleaning incandescent electric lamps." H. J. Haddan. (E. E. Simms, United States.) Dated November 11th. (Complete.)

22,533. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated November 11th. (Complete.)

22,534. "Improvements in means for generating alternating electric currents." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated November 11th. (Complete.)

22,535. "Improvements in starting rotary electric converters." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated November 11th. (Complete.)

22,536. "Improvements in electric circuit changers." The British Thomson-Houston Company, Limited. (E. Oxley, United States.) Dated November 11th. (Complete.)

22,544. "Improvements in collectors for electric railways." O. Kirstein. Dated November 11th.

22,552. "Improvements in electric glow lamps." F. W. Schroeder, A. Couch, and P. W. Moran. Dated November 11th.

22,554. "Improvements in processes and appliances for obtaining carbon suitable for electrical and other industrial purposes, such as the manufacture of electrodes and calcium carbide, and at the same time obtaining a superior quality of pitch." L. Gaster. Dated November 11th.

22,556. "Improvements in and connected with electric bell pushes and light switches and other articles." W. G. Hicks. Dated November 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

4,588. "An improved method of, and means for, holding the bases of electrical fittings within boxes, or upon other surfaces." F. Bathurst. Dated February 24th, 1898. Relates to means for fixing the bases of electric fittings within boxes, or upon surfaces without the necessity for turning. The surface to which the base is to be attached is formed with a boss or projection, on to which a shouldered sleeve screws. The base is bored out so as to fit over the sleeve, and is secured by a screw. This screw may be soldered or otherwise fixed to the sleeve, so that both may be removed together. 4 claims.

4,621. "Improvements in electric arc lamps." A. F. Spooner. (P. Vassia, France.) Dated February 24th, 1898. Relates to arc lamps. An escapement lamp for continuous or alternating current is constructed as shown. The heavier upper carbon holder is hung by a cord, which passes round pulleys to the lower holder. The pulleys are carried in stationary bearings. The pulley is connected by a ratchet wheel with a pawl on an adjacent toothed wheel, which is geared to a shaft carrying a fan and a star wheel. The pulley is carried by a lever fulcrumed in the frame and movable between stops by the core of a shunt solenoid acting in opposition to a spring. The lever also has a finger which engages and stops the star wheel in the position shown. The arc is struck by the lowering of the pulley and the lower carbon, when the core of the solenoid rises in consequence of the carbons coming in contact. Feed of the

carbons occurs when the core is pulled down sufficiently to free the finger from the stop wheel. The arc is surrounded by a small globe supported by the side tubes. 3 claims.

4,636. "Improvements in apparatus for travelling through pipes or conduits more especially intended for use in threading through electric conductors." H. Edmunds. Dated February 24th, 1898. Relates to the insertion of a rope in a pipe or conduit applicable for threading through conductors. Two blocks are connected together by a spring and rod, which is attached to the block and slides through the block. The rod is grooved to receive a guide-feather, and has an enlarged end. Ropes are attached to the block, and after passing over pulleys on the block, return through guides on the block. The blocks are provided with spring arms or brushes which grip in one direction only. The spring connection between the blocks may be replaced by a double solenoid containing a sliding core; an extension on the solenoid carries a pair of wheels set at angle to each other and provided with notches and pawls to allow of rotation in one direction only. The extension on the core carries a similar pair of wheels. The current is switched from one solenoid to the other alternately. 2 claims.

4,646. "Improvements in apparatus for magnetic testing." J. A. Ewing. Dated February 25th, 1898. The magnetic qualities of different specimens of iron or steel are compared by observing the different mechanical forces necessary to remove turned specimen rods from a magnet, against which they are applied sideways. The magnet may be an electro-magnet, used with a constant magnetising force, obtained by supplying a measured current to it, or by adjusting the current until a standard rod is detachable by its proper determined force. In the apparatus shown, the tops of the pole-pieces of a straight electro-magnet are respectively rounded and notched to receive the turned specimen which, in testing, is detached from the rounded pole only. Distance pieces may be used to prevent actual contact. A beam is supported by two pointed screws in a locating hole and slot in brackets projecting laterally from the pole-piece, and carries a part through which the specimen passes. The beam is graduated, and carries a sliding weight to show directly magnetic inductions. A reversing switch and a rheostat for the magnetising current, and an adjustable stop for the beam, are provided. 4 claims.

4,678. "Improvements in insulation of wire for electrical purposes." C. E. Hearson. Dated February 25th, 1898. Conductors are insulated with a solution of celluloid or pyroxylin with colouring matter, such as cobalt blue, or other suitable material in powder form. 1 claim.

4,746. "Method of and means for measuring the work performed in a rotary phase current system." Siemens Bros. & Co., Limited. (Siemens and Halske, Aktiens Gesellschaft, Germany.) Dated February 25th, 1898. Relates to energy meters. In electro-dynameters and motor meters for three-phase alternating currents, two pressure coils are connected mechanically together and move in two fields produced by main current coils arranged so that their effects are additive. A star connection between the three mains is made through three non-inductive resistances, two of the connections including the pressure coils. These resistances are usually equal, but may be adjusted to compensate for inaccuracy in the relations of the coils. In the arrangement illustrated, two field coils inserted in the main oppose the magnetic action of the other coils, which are inserted in the mains connected with the respective pressure coils. In other arrangements, the main includes no field coil. Each of the other mains may include two field coils, one of which has twice the number of turns contained in the other, and which are placed so that the pressure coil is in a field due to the sum of the effects of the large coil in the main and the small one in the main; the other coils are related similarly. In a modification of this arrangement, the large and small coils in each main are replaced by single coils, placed so as to act on the two pressure coils unequally. In a third arrangement, the mains contain equal field coils, but each part of the movable armature has two windings; one of these in each part of the armature is between the main and the star connection. The other windings, situated in the fields due respectively to the currents in the mains are respectively between these mains and the star connection, and oppose the action of the windings connected with the main. 2 claims.

4,747. "Improved means for counterbalancing the frictional resistance in alternating current motor meters." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated February 25th, 1898. Relates to energy meters. Induction motor meters for single or polyphase alternating currents are provided with additional windings to balance their frictional resistances. The invention is applicable to meters having conducting drums rotating between stationary cylindrical laminated iron cores and the poles of laminated iron rings. In the meter shown, two poles have windings carrying the single main current, and two others have windings connected between the mains and carrying a current, which is made to differ 90° in phase from the main current by a bridge arrangement described in Specification No. 9,559, A.D. 1897. The additional winding is connected through an adjustable resistance with the ends of a resistance in the main circuit. These resistances may consist of a single wire with an adjustable connection between its ends. The pressure coils induce a current in the circuit, and the adjacent pole is thus magnetised, when no current is passing in the main circuit, to produce a starting moment nearly able to overcome the frictional resistance of the meter. When current is passing in the main circuit, the inductive action of the coils on the winding is balanced by the connection of this with the main resistance. 1 claim.

4,761. "Improvements in electric controlling and regulating apparatus." W. Emmott. Dated February 26th, 1898. Relates to a means for controlling the light from lamps, such as theatre lamps, supplied with alternating current. An impedance coil divided into sections is included in the circuit, and a switch is provided for varying the number of sections in the circuit. In one arrangement, the impedance coil is of the construction described in Specification, No. 21,236, of 1896, and its sections are connected to the contacts of a switch. In a modified arrangement adapted to be operated by clockwork or otherwise for advertising purposes, a rotary drum fitted with contacts rubs on circularly-disposed contacts. 1 claim.

4,764. "Improved process and apparatus for tanning by the aid of electricity." N. P. Anderson, J. Westengaard, and H. T. Zorener. Dated February 26th, 1898. Relates to an electrical tanning process in which the skins are slowly rotated in a plane at right angles to the direction of the current, which is reversed at frequent intervals by a commutator. The skins are held by hooks carried by five bars supported by spiders upon the shaft. Rotation is effected by a worm and wheel driven by bevel gearing from the main shaft. At each end of the tank is an electrode parallel to the plane of the skins. When treating the hides with thin liquors it is unnecessary to rotate the supporting frame. 3 claims.

4,812. "Improvements in or connected with alternating current electric motors." A. Heyland. Dated February 26th, 1898. Relates to motors in which the speed of rotation can be varied by changing the number of poles. For this purpose, the winding of the inducing element is divided into two parts, and these are connected to a switch, so that the direction of current through one of them may be reversed at will. The winding may be further divided to obtain a larger number of poles. The short circuited rotating element has its winding in two or more sections, connected to the short-circuiting rings in parallel. In one arrangement the induced currents in the two sections flow in the same direction in a two-pole field and in opposite directions in a four-pole field. Sections of the winding may overlap one another at an angle. In another arrangement the sections of the winding are connected together through starting resistances. 3 claims.

4,819. "A method of electrically heating materials in closed chambers and apparatus for that purpose." Electric Reduction Company, Limited. (W. T. Gibbs, Canada.) Dated February 26th, 1898. A closed furnace is provided with one or more rods, supported above the materials to be heated by blocks of carbon or other material and made incandescent by the passage of current through them. Plugged openings and a tube are provided for the introduction of materials and removal of products. The materials are thus heated by radiation only, for fusing, volatilising, decomposing, or otherwise acting on them. 2 claims.

4,829. "Improvements in or relating to electric railway conduits and conductors." A. J. Boult. (R. Sayers, Belgium.) Dated February 28th, 1898. The conductor is made in lengths, and carried in a trough of paper pulp and bitumen, or other insulating material. The trough and a steel section are carried near another section by cross-bearers in a sheet metal casing through which water drains away. A cover-plate affords access to the casing. The section may be a rail, as shown, or may contain an insulating trough for a second conductor. Current is collected from the conductor by wheels held up by spring levers on a trolley carried by rails which may be insulated and used as return conductors. The trolley carries a conducting vertical blade, enclosed in insulating material in a steel casing, which projects between the sections and is connected by cords with the car. Where conduits cross, the insulating troughs and conductors are interrupted by slots only. At points the insulating trough, conductor, and trolley rails, are placed in a sheet metal casing, slotted at the top and movable laterally below the slotted top of the outer fixed casing about a pivot at one end. In order to give room for this, the trolley rails are lower at the points, short inclines being provided at the ends of such parts. 5 claims.

5,766. "Improvements in a method of and means for making connection between an underground conductor and a vehicle motor." H. L. Butler. Dated March 9th, 1898. Relates to electric railways and tramways on a road contact system with switches thrown by magnets on the vehicle, and more especially to conductors, switches, and collectors. Reference is made to Specification No. 1,493, A.D. 1898. The switches are contained in segmental boxes pivoted in frames secured to the rails, &c. These boxes are preferably made in two halves, and the lead from the main is brought in at the pivot. The circuit is completed when the box is lifted by a weighted flexible strip, which is connected to a block or to side projecting lugs from which current is taken by the collector. A second protecting casing may be provided inside the box. If an insulated return is to be used, the switch arrangements are duplicated into the positions shown simultaneously with the engagement of lateral pins with guide bars, which thus automatically tip and discharge the bucket. 6 claims.

5,823. "Improvements in and in connection with underground conduit electric railways." E. Heyl-Dia. Dated March 9th, 1898. Relates to electric railways and tramways on a conduit system with insulated contacts and mechanically operated switches. A long collector or slipper travelling in the conduit depresses the end of the lever and completes the circuit at the spring contacts to the main conductor. A spring or weight returns the lever which is pivoted, and passes through a flexible water-tight diaphragm. In a modification, the lever is arranged to work horizontally. 3 claims.

6,022. "Improvements in primary voltaic or galvanic batteries." P. Lafargue and E. Drouet. Dated March 11th, 1898. The plates or electrodes consist of a split tube of zinc having a metallic strip fixed to it and a perforated carbon tube having a central perforated diapragm. The tube is fitted axially in a porous cell by means of a ring. The lower part of the tube and the space between it and the porous vessel is packed with fragments of gas-retort carbon. In the upper part of the tube is a carbon plate which is held in place by a wedge, and in this same part is placed a quantity of potassium chlorate. The electrolyes are sulphuric and nitric acid respectively, the latter being used in the porous cell and the former in the space surrounding the zinc. In a modification the carbon electrode is in the form of a rectangular block having on each side of it carbon rods, and all held in place by a ring. The space between the carbon and the porous cell is packed with crushed or granulated carbon. Holes are made through the upper part of the block and serve for the introduction of the potassium chlorate and nitric acid. When the cell is in use, one of the holes may be closed and a fine glass tube serving as a gas exit may be placed in the other hole. 1 claim.

6,024. "Improvements in and relating to conduits for electric cables." W. Sykes. Dated March 11th, 1898. Conduits are formed of earthenware, &c., sections in which a number of circular tubes are formed parallel. The sections fit by spigot-and-socket joints on to and into which have been cast linings, preferably of bituminous material. The casting is done by means of steel dies with centring projections. When the tubes are fitted without previously formed joint liners, a centring mandrel is employed and the joint is made good with cement. In a further modification the ducts may be in the form of troughs which are filled with bituminous material and covered with flat lids after the cables have been laid. The lining composition preferred consists of gas tar, pitch, sulphur, and ground limestone boiled together. 3 claims.

6,025. "Improvements in and relating to draw and junction boxes for electric mains." W. Sykes. Dated March 11th, 1898. Junction boxes for use with conduits or armoured conductors are formed in sections which may be built up in position. One form is described in which a bottom tray is formed with a central cavity for the junctions or other necessary apparatus, a water or drainage ring, and an outer flange. The flanges and sides of the cavity are grooved to receive the cables, and the lower part of the body is grooved to fit over the cables. The upper part of the body is provided with a lid fitting by means of bitumen screws and a washer as described in Specification No. 7,498, A.D. 1893. The lid may have a metal surface and key recesses in a surrounding protective collar. One or more branch connections may be formed. The shape of the tray may be modified, and the whole bottom part may form a conduit section, or the part may be built on to an open conduit section when adapted for drawing through. In the case of service boxes, the bottom section may be plain and a screw lid without the metal surface employed. 3 claims.

6,058. "Apparatus for transmitting motion to a distance by means of electrical energy." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated March 11th, 1898. Relates to improvements upon the apparatus for transmitting motion to a distance described in Specification No. 8,011, A.D. 1897. Instead of the transmitter and receiver being alike, the desired differences in phase or amplitude may be produced at the distant point by suitable means at the transmitting point, such as the inclusion or exclusion of coils in a transformer. One arrangement for a three-phase current system consists of a generator, the transmitter and the transformer. The coils of the transformer are divided into sections, and these are connected to contacts similarly lettered on the transmitter. The transmitter has six radial arms rubbing over six rings connected to the coils of the receivers. Under these conditions any movement of the transmitter which requires very little energy will be repeated by the receiver. In modifications, the transformer may have a secondary winding which is connected to a distant point, or the transformer may be arranged for other than three-phase currents, and may be adapted to produce a rectilinear motion. 1 claim.

6,135. "Improvements in electric incandescence lamps." W. Nernst. Dated March 12th, 1898. Relates to incandescent lamps. Rods or filaments which become conductive only when heated by auxiliary means before they can be rendered incandescent electrically, as described in Specifications Nos. 19,424 and 3,470, A.D. 1897, are now made of an oxide such as zirconia, magnesia, or thoria mixed with a large or small proportion of another oxide or other substance, yttrium, cerium, erbium, and didymium oxides, boric acid, calcium chloride, and tungstic acid being mentioned for this purpose. It is stated that such bodies can be heated by a match flame sufficiently to become incandescent with 100 volts. 3 claims.

6,145. "Process for hardening and rendering tenacious the active mass of electric accumulators." R. von Barby. Dated March 12th, 1898. Secondary batteries.—The active material is hardened and rendered tenacious by mixing it, *i.e.*, red lead, with pure water, half drying the mixture, and then exposing it to the vapours of indigotin, acetic acid, phenol, alizarin, pyroracemic acid, or other organic substance capable of forming compounds with the lead oxide. 1 claim.

6,350. "Improvements in or connected with the manufacture of carbons for electric arc lamps." J. J. Waddington. Dated March 15th, 1898. Relates to arc lamps. Carbons are provided with cores of plaster of Paris, or of a mixture of this with strontia and carbon dust, or with soda, or of other materials, to increase and colour the light produced, and so render it more suitable for certain photographic purposes, or more capable of penetrating fog when used as a search light. The material may be made into a paste with water and rammed into holes bored in the carbons. 1 claim.